STORM DRAIN MASTER PLAN (SDMP) PHASE 2

City of Santa Ana, Orange County, California

Prepared for:

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Public Works Department
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CITY OF SANTA ANA

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List of Abbreviations and Acronyms

1D	One-Dimensional
2D	Two-Dimensional
AES	Applied Engineering Solutions (Hydrology Software Program)
AMC	Antecedent Moisture Condition
As-builts	Construction Plans
BMP	Best Management Practice (Water Quality Treatment Facility)
CB	Catch Basin
cfs	Cubic Feet per Second
CSDP	Comprehensive Storm Drain Plan
DBL	Double
EPA	Environmental Management Agency
FEMA	Federal Management Agency
GIS	Geographic Information System
HGL	Hydraulic Grade Line
IB	Infiltration Basin
ID	Identification
LID	Low Impact Development
MH	Manhole
MPD	Master Plan of Drainage
N/A	Not Applicable
NC	Natural Channel
NPDES	National Pollutant Discharge Elimination System

RCB	Reinforced Concrete Box
RCC	Rectangular Concrete Channel
RCP	Reinforced Concrete Pipe
RWQCB	Regional Water Quality Control Board
SBCFCD	San Bernardino County Flood Control District
SWMM	Storm Water Management Model
SWPPP	Storm Water Pollution Prevention Plan
TC	Time of Concentration
TDA	Tributary Drainage Area
USACE	United States Army Corps of Engineers
WSPGW	Water Surface Profile Gradient for Windows (Hydraulic Software)
WxH	“Width” by “Height”

1 Introduction

1.1 Purpose

The purpose of this study is to provide comprehensive long-range planning for the implementation and development of storm drainage facility improvements in the City, determine the capital improvement costs, identify grant opportunity programs, and discuss priorities of the drainage improvements. The City of Santa Ana encompasses approximately 27 square miles and is located adjacent to the cities of Orange, Garden Grove, Westminster, Tustin, Irvine, Costa Mesa, and Fountain Valley. The Santa Ana River and Santiago Creek run through Santa Ana, carrying flows to the ocean.

Evaluation of the drainage patterns and storm drain recommendations is divided into seven (7) separate sub-watersheds, which are identified as the Delhi, Gardens, Greenville Banning, Lane Barranca, Santa Ana, Santa Fe, and Wintersburg. These sub-watersheds are tributary to three main watersheds, San Diego Creek, Santa Ana River and East Garden Grove-Wintersburg Watersheds. This Master Plan is based on the criteria outlined in the *County of Orange Local Drainage Manual dated January 1996*. Figure 1-1 is a project location map showing the general extents of the seven regional sub-watersheds.

1.2 Background and Previous Study

The City of Santa Ana Storm Drain Master Plan (SDMP) Phase 1 was completed by Michael Baker International in December 2015. This Phase 1 SDMP included performing hydrology for the 10-, 25- and 100-year storm events according to the Orange County Hydrology Manual. The hydrology was the basis for the hydraulic analysis using the Bentley CivilStorm program. The study provided recommendation for storm drain improvements within the City boundaries. The total capital improvement cost was estimated at $640,000,000.

Prior to the Phase 1 study, the City of Santa Ana had adopted an SDMP published in 1994 by Boyle Engineering Corporation (Boyle) which utilized normal depth calculations to size all storm drain systems. The 1994 study used a variation of the expected value hydrology from the County's Hydrology Manual. The expected value models are used for floodplain mapping, sediment studies and sometimes to analyze existing systems.

1.3 Existing Watershed Description

The Santa Ana watershed lies in the coastal plain adjacent to the Santa Ana River. Figure 1-2 shows the Regional Location Map. The climate is characterized by dry summers and moderate winters. A major portion of the precipitation occurs between December and March. The topography of the area is flat, sloping from northwest to southwest at approximately a 0.5 percent grade. The watershed is fully urbanized. Storm runoff is generally intercepted by local City facilities then conveyed to major County facilities to the Pacific Ocean. Flows from the cities of Orange, Garden Grove, and Tustin to the north and east are intercepted by the Garden Grove (SR-22) and Newport (SR-55) Freeways and thus do not impact the City's drainage system. Along the west and south boundaries of the City, either flows are intercepted by the City or County facilities, or they exit the City as street flow.

The existing drainage system in the City of Santa Ana consists of City, County, and Caltrans facilities. Storm runoff within the City limits is generally intercepted by a network either of City facilities, or within the freeways and associated right-of-way areas by Caltrans facilities. The City storm drain system consists primarily of reinforced concrete pipe (RCP) ranging in size from 18 in to 90 in; however, there are also a few reinforced concrete box (RCB) facilities ranging in size from 4 ft. x 2 ft. to a double 10 ft. x 5.33 ft. Most of the RCB's are within major streets.

1.4 FEMA Floodplain Mapping

The City of Santa Ana is a participant in the National Flood Insurance Program (NFIP). Communities participating in the NFIP must adopt and enforce minimum floodplain management standards, including identification of flood hazards and flooding risks. Participation in the NFIP allows communities to purchase low cost insurance protection against losses from flooding. The maps are effective December 3, 2009 with various floodplain changes such as Letter of Map Revisions (LOMR) that were approved after the published date. The FEMA Floodplain Map is shown on Figure1-3.

2 Technical Approach

2.1 Phase 1 SDMP

The land use data and hydrologic soils information in the Phase 1 SDMP was sufficient for this study. No changes were necessary. The Bentley CivilStorm hydraulic models were converted to XPSWMM for the 1D/2D modeling. All the geometric data (inverts, pipe sizes, ground elevation etc.) from Phase 1 were supplemented with additional as-builts (where available) and discussed in detail within each watershed discussion. The gutter links modeled in Phase 1 were removed in this study, as these are now represented as a 2D (surface) component of the hydraulic modeling.

2.2 Hydrology Analysis

The discharges (which include the small area hydrographs) used for this study were obtained from the SDMP Phase 1 project. These discharges included the 10-year and 100-year high confidence (85% confidence interval) flows.

High confidence flows are typically used for flood control design purposes. However, an expected value (50% confidence level) analysis was also prepared for a “test” area to evaluate the benefits of reduced discharges to the capital improvement costs. According to Orange County Hydrology Manual (OCHM), expected value discharges should be used for the following cases:

- Implementing development mitigation requirements.
- Floodplain delineations under existing conditions.
- Estimation of water resources variables, such as sedimentation and water quality.
- Evaluating the protection level provided by existing facilities.

The Delhi watershed was used a “test” watershed for the expected value hydrology analysis. The results of the expected value for the Delhi watershed are discussed in Section 5.

Based on the “test” model results and discussion with the City, it was agreed that the high-confidence hydrology would be used for the hydraulic evaluation of the drainage system for all county watersheds. The hydrology results can be found in Appendix A.

2.3 Design Criteria

Street capacity deficiencies were determined based on the County of Orange design protection levels for streets from the *County of Orange Local Drainage Manual dated January 1996.* Refer to Table 2-1 for the design protection levels associated with the 10- and 100-year conditions. The equivalent maximum allowable flow rate was determined based on a typical street cross section and the associated maximum allowable depth.

Table 2-1: Design Protection Levels for Streets

Type of Street	10-yr Maximum Allowable Flooding	10- yr Max Allowable Depth (ft)	10-yr Max Allowable Flow (cfs)
Local	Top of Curb	0.5	16
Arterial (100’)	One 12’ Travel Lane Free of Flooding	0.55	22
Arterial (120’)	One 12’ Travel Lane Free of Flooding	0.73	54

Type of Street	10-yr Maximum Allowable Flooding	10- yr Max Allowable Depth (ft)	10-yr Max Allowable Flow (cfs)
Local	At or Below ROW Line	0.71	53
Arterial (100’)	At or Below ROW Line	0.83	81
Arterial (120’)	At or Below ROW Line	0.85	88

The majority of arterial streets within the City of Santa Ana were generalized to follow the criteria of the Arterial (100’) section listed in Table 2-1. The guidelines above and the flooded area evaluation (Section 2.6) was established as a baseline for ultimately determining storm drain configurations that would mitigate existing condition deficiencies.

2.4 Hydraulics

2.4.1 Technical Software - XPSWMM

This study was performed using a state-of-the-art hydrologic and hydraulic approach because of the area’s unique drainage characteristics. XP Solution’s XPSWMM, which is an improved version of the U.S. EPA Storm Water Management Model (SWMM), was used for this flood evaluation. XPSWMM is on the Federal Emergency Management Agency (FEMA) list of acceptable hydraulics software for such studies. XPSWMM is a dynamic wave model that solves the full St. Venant Equations. Dynamic modeling allows the effects of storage and backwater in conduits and floodplains and the timing of the hydrographs to yield a true representation of the hydraulic conditions. XPSWMM can model the surface in two dimensions, while linking to the subsurface infrastructure, or storm drain system. The result is a comprehensive model that can dynamically communicate between the surface and subsurface facilities throughout the modeled design storm duration. Using these advanced modeling techniques, hydraulic analyses were completed for both baseline (existing) and proposed alternative conditions using a linked 1 Dimensional subsurface and 2 Dimensional surface model (1D/2D) in XPSWMM (see Figure 2-2). The XPSWMM files can be found in Appendix D.

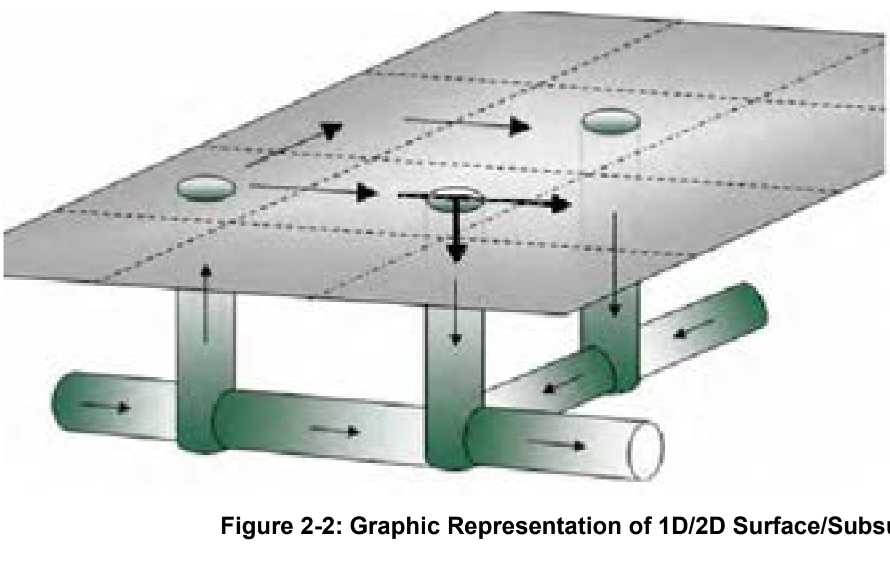


Figure 2-2: Graphic Representation of 1D/2D Surface/Subsurface Model

2.4.2 Topography

Topography is one the most important parameters for 2D model. The topography was provided by the City; however, no records of vertical accuracy were located. The study was performed using the North American Vertical Datum of 1988 (NAVD88).

2.4.3 1-D Model Development

The existing storm drain systems were imported from the Phase 1 SDMP CivilStorm model into XPSWMM as 1Dimensional (1-D) elements. XPSWMM has the ability to create separate, yet linked, models: A surface model based on 2Dimensional topographic grid; and a subsurface model, based on a link-node 1 Dimensional geometry. XPSWMM links and runs both models simultaneously. Figure 2-3 shows a schematic of the 1D/2D connection. The node communicates between the surface and the subsurface (conduits, culverts).

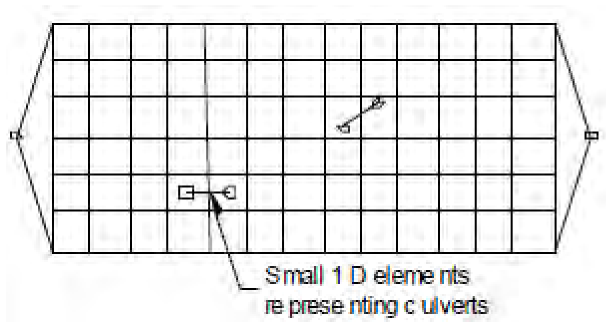


Figure 2-3: Graphic Representation of 1D/2D Surface/Subsurface Model

2.4.4 Grid Size

The grid cell resolution is an important consideration in two-dimensional modeling. Small grid cell sizes increase accuracy but require additional computation times; while larger grid sizes compromise accuracy but decrease computation time. The determination of grid size requires a trade-off to ensure a workable model without compromising satisfactory accuracy. Multiple cell sizes (multiple domain) can be specified within one model, allowing a larger grid size to be used in areas were high detail is not required and a smaller grid size to be used in primary areas of interest. The grid size specified in this study was intended to replicate the hydraulic behavior of the drainage watershed. It is recommended to have major 2D surface flowpaths (such as streets, open channel) to be represented by at least three to four cells across them. This study used a 15-ft grid size as it better reflects the conveyances (street surface) within the City and captures enough detail for the hydraulic routing.

2.4.5 Inlet Capture Curves

The existing inflow capture curves developed in the Phase 1 SDMP were used for the 1D/2D modeling. Detailed discussions of the existing inflow locations are discussed in each of the watershed where some locations were split or some areas where the 2D capture equation was used. Nodes that represent catch basin inlets are linked to the 2D surface, allowing flow to be freely exchanged between the 2D surface flow and 1D storm drain system. In order to model the hydraulics of a catch basin, a 2D capture equation can be specified. The 2D inflow capture equation is a basic orifice equation and specifies a power curve representing the capture of 2D flow at a node as a function of depth. The coefficient of the power curve can be modified according to the size of the catch basin, meaning larger catch basins can be modelled more realistically and capture more flow while smaller catch basins will capture less flow. The 2D inflow capture equation is of the form $Q = C \times D^{0.5}$, where Q is the inlet captured flow rate, D is the depth on the 2D surface, and C is a user specified coefficient assigned according to the size of the catch basin. In order to determine the appropriate capture coefficient for each catch basin size, a rating curve was developed assuming the catch basin acts as a sharp-crested orifice. A best-fit line of the same form as the 2D inflow capture equation was generated for the rating curve. The coefficient from this best fit line was then used as the coefficient for the corresponding catch basin size. Table 2-2 shows catch basin sizes and their corresponding inlet capture coefficients. The inflow capture curves can be found in Appendix F.

Table 2-2: 2D Capture Curves Coefficient, C

Inlet Size	Coefficient, C
2'x4' Grated Inlet	30
2'x8' Grated Inlet	63.5
3' Catch Basin	8.1
3.5' Catch Basin	9.6
4' Catch Basin	10.8
5' Catch Basin	13.8
6' Catch Basin	16.15
7' Catch Basin	18.85
10' Catch Basin	36
12' Catch Basin	43.25
14' Catch Basin	50.5
21' Catch Basin	75.7
24' Catch Basin	86
28' Catch Basin	102.1

2.4.6 Outlet Tailwater - HEC-RAS (1D) Model

The 1D channel hydraulics for portions of the Santa Ana SDMP Phase 2 were developed using the Hydraulic Engineering Center – River Analysis System (HEC-RAS 4.10) from the U.S. Army Corps of Engineers (USACE). HEC-RAS is a one dimensional (1D), rigid boundary model that assumes that the channel bed does not move. The program is intended for calculating the water surface profile for steady and gradually varied flow in natural and manmade channels.

The hydraulic analysis was performed for multiple channel locations within the City of Santa Ana. The assumptions for channel geometry, design flowrates, Manning’s “n” value, and boundary conditions are discussed within each watershed analysis. The HEC-RAS files can be found in Appendix E.

2.5 Model Validation

Model validation is an important aspect for this study. Historical known flooding locations, maintenance logs, resident complaint descriptions and flooding photographs form a good basis to compare hydraulic modeling results to known events. The correlation process provided a level of confidence that the rainfall-runoff relationship of the models was performing adequately. A detailed discussion is included for each watershed.

2.6 Flooded Area Evaluation

The existing condition hydraulic results allows the ability to assess drainage infrastructure deficiency and are used as a baseline condition for comparison with proposed drainage improvements and mitigation. In order to evaluate areas of flooding within each watershed, the following indicators were considered to determine the significance of flooding within each area.

2.6.1 Critical Facilities

Based on FEMA, the term "critical facilities" is used to describe all manmade structures or other improvements that, because of their function, size, service area, or uniqueness, have the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if they are destroyed, damaged, or if their functionality is impaired.

Critical facilities commonly include all public and private facilities that a community considers essential for the delivery of vital services and for the protection of the community. They usually include:

- emergency response facilities (fire stations, police stations, rescue squads, and emergency operation centers [EOCs]);
- custodial facilities (jails and other detention centers, long-term care facilities, hospitals, and other health care facilities);
- schools;
- emergency shelters;
- utilities (water supply, wastewater treatment facilities, and power);
- communications facilities;
- and any other assets determined by the community to be of critical importance for the protection of the health and safety of the population.

Based on discussion with the City, areas of high economic value to the City were included in the assessment and protection during a storm event.

The critical facilities are shown on Figure 2-3. The facilities data were provided by the City in GIS shapefile format. This allowed proposed mitigation or recommended improvements to be focused on alleviating the flooding inundation in such areas/locations.

2.6.2 Maximum Depth

The hydraulic modeling allows results to be displayed in terms of maximum ponding depth. This is the highest depth at each cell (location) that occurs during a particular storm event, such as a 10-year or 100-year storm. This result parameter helps to clearly identify ponded areas where flood depth exceeds existing street curbs or right-of-way. According to the various Emergency Management Handbooks "Deep floodwaters can be dangerous because they can destabilize people and cars, and carry them away, resulting in injuries and fatalities. For instance, 3-feet deep water with no velocity is sufficient to prevent able-bodied adults from wading."

2.6.3 Duration of Inundation and Time to Inundation

The time to inundation and duration of inundation are important parameters, especially for emergency planning purposes. The time to inundation represents the time it takes to achieve the flooded (i.e. depth threshold) results at a particular location, while the duration of inundation is the time the flooding (ponding) remains at a particular location. These results parameters allow users to visualize how long it takes to reach certain depths of flooding at critical locations within the City. Effective warning time is the time available for people to undertake appropriate actions, such as elevating or removing belongings and evacuating people and pets.

2.7 Priority Projects

The goal of the priority ranking system was to determine the projects of the greatest impact (flood reduction, water quality benefits, cost and potential for grant funding) and hence should be constructed first when funding becomes available. Section 13 Capital Improvement Plan breaks down the priority ranking criteria and ranks the proposed drainage improvements projects.

2.8 Cost Estimates

Cost estimates were created for the proposed condition analyses. The unit prices were based on current market prices, and overall cost calculation was presented using an Excel spreadsheet.

The calculated system costs estimates include costs for engineering, construction, a stormwater management plan (SWPPP), surveying, construction management, and contingencies. Any new storm drain construction within the City most likely will require costly utility relocation. This can be very costly and especially considering the entire City is highly urbanized and with infrastructure dating back to the early 1900s. A line item has been added to estimate utility relocation for each improvement system. The quantity and complexity of utility relocation is unknown and requires detailed site-specific subsurface investigations.

Pipe costs are per linear ft and included costs for excavation, shoring, bedding, backfill, compaction, removal of excess material, and trench resurfacing.

Because construction will take place over a number of years, the total cost of master plan implementation will vary from the numbers provided in this study. It is recommended that the any future implementation plans take into account future construction unit costs and utility relocation requirements prior to creating a funding program for the SDMP. Detailed calculations can be seen in Appendix C.

3 Grant Funding

Table 3-1 lists various Federal, State and local grant funding opportunities that the proposed master plan drainage improvements may qualify for. Table 3-1 lists local grant funding opportunities.

Proposition 40, the "California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002" provided a bond issue of $2,600,000 to provide funds for projects to include those which protect rivers, lakes, and streams to improve water quality and ensure clean drinking water. Unallocated funds from Prop 40 are being administered through the State Water Resources Control Board (SWRCB) to fund projects designed to implement storm water runoff reduction with emphasis on Low Impact Development projects.

Table 3-1: State Grants

Grant Opportunity	Eligible Projects	Application Info	Grant Summary	Deadline	Source
SWRCB Proposition 1 Storm Water Grant Program	Green Infrastructure Rainwater and Storm water capture projects Storm water treatment facilities Storm water resource plan development (planning grant)	Anticipated Round 1 amounts: - $20 million for planning - $80 million for implementation - Planning grant maximum: $500,000 - Construction Grant Maximum: $5 million	Projects must - be included and implemented in an adopted Integrated Regional Water Management Plan - be listed in a Storm Water Resource Plan - be multi-benefit - be consistent with regulatory requirements and capable of long-term benefit for 20 years.	Solicitation for Implementation Round 2 is tentatively scheduled for late 2018 or early 2019	https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swgp/prop1/
SWRCB Loan Forgiveness Available for Green Projects	Must be a Clean Water State Revolving Fund (CWSRF) Green Project Reserve (GPR) project. PR projects must address water or energy efficiency, mitigate storm water runoff, or encourage sustainable project planning, design, and construction.	50 percent of actual GPR eligible costs; 75 percent for GPR eligible planning costs; Maximum loan forgiveness per project: $4.0 million	Fits in one or more of: green infrastructure, water efficiency, energy efficiency, environmentally innovative projects	Ongoing	https://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/

Grant Opportunity	Eligible Projects	Application Info	Grant Summary	Deadline	Source
Drought Resiliency Projects for Fiscal Year 2017 Department of the Interior Bureau of Reclamation	Proposed projects must be supported by an existing drought planning effort.	$750,000 max	Funds projects that increase the reliability of water supply; improve exchange of water; and provide benefits for fish, wildlife, and the environment to mitigate impacts caused by drought	closed for 2018; potential future grants	https://www.usbr.gov/drought/

Table 3-2: Local Grants

Grant Opportunity	Eligible Projects	Application Info	Grant Summary	Deadline	Source
Water Funding Opportunities					
Orange County Transportation Authority (OCTA) Measure M Environmental Cleanup Program Tier 1	Public agencies of Orange County cities and County of Orange	in 2016: $200,000 max per project	Funding for equipment purchases and installation to existing catch basins and related best management practices such as screens, filters, inserts, and other "street scale" low flow diversion devices.	To be determined	http://www.octa.net/Projects-and-Programs/Plans-and-Studies/Funding-Programs/Call-for-Projects/The-Environmental-Cleanup-Program-Call/
OCTA Measure M Environmental Cleanup Program Tier 2	Public agencies of Orange County cities and County of Orange	Dependent on money received	Funds regional, multi-jurisdictional, capital-intensive projects that mitigate pollutants. Examples include constructed wetlands, bioswales and detention/infiltration basins.	To be determined	http://www.octa.net/Projects-and-Programs/Plans-and-Studies/Funding-Programs/Call-for-Projects/The-Environmental-Cleanup-Program-Call/

4 Delhi Channel Watershed

The Santa Ana-Delhi watershed is approximately 17 sq. miles and lies primarily within the Cities of Santa Ana and Costa Mesa. The entire watershed is within the City of Santa Ana. The Delhi system includes networks that are tributary to the Delhi Channel (County Facility F01). The watershed is generally bounded by 17th Street to the north, Bristol Street to the west, Sunflower Avenue to the south, and Grand Avenue to the east. The watershed is developed with commercial, mixed use, residential and civic land uses. Runoff from the watershed flows to the Delhi Channel (OCFCD Facility F01) through street gutters and storm drains. Figure 4-1 shows the Delhi watershed subarea map.

All storm drain within the Delhi watershed generally joins two main lines that flow south and connect downstream to the Delhi Channel. These two main lines are referred to as the “eastern” and “western” main lines. The Rouselle (eastern) drainage system between Warner Avenue and 1st Street drains approximately 1,300 acres. The Rouselle system ranges from 24-in RCP at the system headworks to 60-in RCP at Warner Avenue. The western system along Flower Street drains approximately 1,500 acres.

4.1 Existing Condition

The existing condition flood routing analyses were performed to identify existing street surface conveyance and storm drain capacities and to acquire a benchmark for the proposed analyses. The 10- and 100-year annual chance models were then calculated to develop a basis for the evaluation and development of potential drainage improvements.

In this study, the following updates were made to the SDMP Phase 1 hydrology delineation and/or storm drain geometry. This update/revision is to further define the drainage pattern.

Subarea 6

1. The existing 24-in RCP from Bush Street to French Street along 3rd street was modeled. This system included three catch basins at the system headworks.

Subarea 15

2. Northeast of the intersection of Edinger Avenue and Maple Street, at the Oak Street/Hood Avenue street knuckle, there are two catch basin inlets and a 24-in RCP connecting to the eastern drainage, no as-builts were available. The size was obtained from the OC Facility Map and verified using Google Earth Street view.

Subarea 21

1. Santa Ana Blvd Pump Station: The Santa Ana Pump Station (Santa Ana PS) is located adjacent to the retaining wall on the north side of Santa Ana Boulevard; it pumps stormwater to a nearby culvert on Santa Ana Blvd.
2. Flower St. Pump Station: The Flower Pump Station (Flower PS) is located in the south-west corner of the Civic Center parking lot, adjacent to the retaining wall at the intersection of Flower Street and Sixth Street; it pumps discharges to a 16-in gravity pipe along Flower Street.

Subarea 30

1. The catch basin inlets as part of the storm drain along Edinger Ave. were verified and updated based on as-built drawings. Three catch basins were added based on Google Earth and the inflow was calculated using the 2D Capture curves described in Section 2.4.5.

Subarea 38

1. Additional catch basins were modeled per the as-built drawings and the unit hydrograph were split evenly for each inlet location.

Subarea 40

1. The catch basin inlet at the intersection of Adams St and Orange Ave were split into eight inlets as shown on the as-built drawings. This required the flood hydrograph to be split appropriately.

Delhi Channel Tailwater

The Delhi channel was modeled in HEC-RAS using as-built drawings and topography for the geometry from Keller Ave. to the confluence with Gardens Channel (Sunflower Ave. and Park Center Dr). The 100-year discharge (4,000 cfs) for the HEC-RAS model was obtained from the Orange County Deficiency study and the 10-year discharge (2,300 cfs) was interpolated to be more conservative. The depth of the channel in the 10-year event is 8.09 ft, which is used as the tailwater/head boundary for the 2D modeling. The 100-year depth is 11.89 ft. The values used in the SDMP Phase 1 Study were 9.46 ft. and 10.23 ft. for the 10-year and 100-year, respectively, based on normal depth using Bentley FlowMaster. The HEC-RAS results can be found in Appendix E.

4.1.1 Existing Condition Results

Though the entire watershed was analyzed in this study, the existing condition results discuss the major flooding locations within the Delhi watershed. These locations are either effecting Critical infrastructure such as police department, fire department, hospitals, schools or business districts where depths are higher than 0.5-ft (maximum allowable for local streets) or pond for a longer period (over 3hrs). Other locations of known flooded areas are included in this discussion.

Figure 4-2 and Figure 4-3 show the 10-year and 100-year existing condition maximum depth results. Figure 4-4 and Figure 4-5 show the 10-year and 100-year existing condition duration of inundation maps.

4.1.1.1 Downtown Flooding

Santa Ana Downtown area is bounded by Civic Center Drive to the north, Main Street to the east, Flower Street to the west and 1st Street to the south as shown in Figure 4-1.1.

Subarea 2

Santa Ana Boulevard is the future alignment for the OC StreetCar. The OC StreetCar alignment starts at the Santa Ana Metrolink Station, goes west, and terminates at Harbor Boulevard. The proposed Storm Drain system along the Street Car alignment is discussed in Section 5.2. The proposed alignment crosses through three (3) watersheds: Santa Ana-Delhi, Gardens, and Wintersburg.

- Santa Ana Metrolink Station to French Street – The tributary area is 193 acres and the existing storm drain system ranges from 24-in to 27-in RCP. The existing condition shows maximum flood depths up to 1 foot in the 10-year storm event mainly due to undersized storm drains and catch basin inlets. This system drains to the eastern drainage system.
- Intersection with Flower Street – Ponding (approximately 1-ft) is shown on the north-east corner of this intersection.

Subarea 20

Multiple locations along Civic Center Drive shows flood depths ranging from 0.1 ft to 0.5 ft in the 10-year storm event. Civic Center Drive lies in the most upstream of the Delhi watershed, and its tributary area is split to eastern and western drainage systems. The flooding along Civic Center Drive is mainly caused by undersized inlets and storm drain systems.

Subarea 21

3rd Street is in the heart of downtown Santa Ana and flooding along this street causes disruption and damage to business and could be health hazard to the public. The flooding along 3rd Street range from 0.15 ft to 1.26 ft in the 10-year storm event. The 3rd Street storm drain system drains into the western drainage of the Delhi watershed. Most of the flooding is due to undersize storm drain system (including catch basin inlets). The existing storm drain system is a 24-in RCP draining approximately 36 acres of urbanized land cover. In addition, a portion of the flooding is also caused by overland runoff from upstream (due to undersize storm drain system) that flows along Main Street (See Civic Center Drive discussion) and flows west on 3rd Street. The existing capacity of the 24-in RCP with an average slope of 0.0056 is 17 cfs and the hydrology shows a 10 year flow of 67 cfs.

Subarea 6

The 10-year storm event results show a flooding depth of 0.6 foot at the intersection of 4th Street and Bush Street. Based on available topography, this area is very flat with a very shallow cross-gutter. Runoff (uncaptured flows) from undersized Civic Center Drive systems to the north is conveyed south along Bush Street to 4th Street. There are no existing storm drain systems at this location.

The flooding depth at the intersection of 3rd Street and Bush Street is between 0.5-1.0 ft in both the 10-year storm event and the 100-year storm event. There are existing catch basin inlets along Bush Street on the north and south of 3rd Street and one inlet on 3rd Street. The tributary area to these inlets is approximately 20 acres. Based on the results of this study,

1. Overland flow travels from the north along Bush Street to the intersection. Approximately 43 cfs in the 10-year and 110 cfs in the 100-year flow south on Bush Street contributing to the flooding.
2. This drainage system connects to the Rouselle (eastern) System, which has a HGL of 120.7 ft which is 2.5 feet higher than the flowline at the headworks for the 3rd Street storm drain.

Subarea 12

The drainage pattern along Chestnut Avenue near Halladay Street is conveyed within the existing streets. There are cross-gutters along Chestnut Avenue that directs flow west towards Maple Street. There are no storm drain systems at this location causing some flooding along the street.

Subarea 15

The 10-year storm results show a flooding depth of 1-ft to 2-ft along Edinger Avenue just east of Maple Street. This is a sump (lowest) location where all the runoff collects before it is conveyed by the existing 39-in RCP. This system joins the 51-in RCP eastern drainage system. The tributary area to the 39-in RCP is approximately 38 acres. Flooding at this location is caused by undersized drainage system (storm drain and catch basin inlets) and overland runoff from upstream areas.

Subareas 18 & 19

The flooding depth at the intersection of Warner Avenue and Rouselle Street is approximately 1.2 ft in the 10-year storm event. Runoff generally flows south and east towards the Rousell drainage system.

Runoff is primarily overland flow until it reaches the catch basin inlets along Warner Ave. The flooding is caused by undersized storm drain system along Warner Ave. and Rouselle Street. The existing 60-in RCP downstream of the intersection is draining approximately 1,300 acres, which is at-least 40-percent of the Delhi Watershed. The system extends north of Warner Avenue along Rouselle Street for approximately 15,000-ft (2.75 miles).

The tributary area to the Warner system is approximately 226 acres. The total tributary area to the Rouselle system is approximately 1,095 acres. The runoff flows south with combination of overland street flow and a complex network of storm drains.

Subarea 35

The flooding depth at the intersection of Bristol Street and Warner Avenue is approximately at the curb height (0.5-ft). The entire street is flooded in the 10-year storm. Currently, Bristol Street has no existing storm drain systems to capture the overland flow from the north originating from undersized systems along Flower Street and Civic Center Drive.

Subarea 38

The flooding depth at on Hemlock Way west of Flower Street is approximately 2 ft in the 10-year storm event. Runoff that is not captured along Warner Ave SD generally flows south to Hemlock Way. The system along Hemlock Way (60” RCP) is effected by the highwater surface within the Delhi Channel.

Subarea 41

The sump location in the Bradford Housing tract receives overland flow from the north (Dyer Rd). The undersized inlet connects to an existing squash box (6’W x 1.3’H). The ponding at this location (along Bradford Pl and Carriage Dr) ranges from 0.5 ft to over 2 ft in the 10-year storm event.

4.1.1.2 Delhi Model Validation

The 10-yr storm was used to correlate the hydrology and hydraulic model results to the existing photos and eyewitness descriptions of the flooding that occurred on January 22, 2017. This correlation process was conducted by comparing flood depths in the model results to flood depths seen in the photographs and eyewitness accounts, and reasonably modifying model parameters until the flood depths in the model correlated to the depths seen in the photographs. The correlation process provided a level of confidence that the rainfall-runoff relationship of the models was performing adequately.

The Delhi model was validated by comparing flooding at the intersection of Bush St and 3rd St. Photos were taken at the intersection during the January 12, 2017 storm showing 0.5-1.0 feet of flooding (see Section 4.1.2). Both the 10-year and 100-year show flooding of 0.5-1.0 feet in that intersection.

The model was further validated by comparing flooding at the intersection of 3rd St and Main St. Photos were documented at the intersection showing 0.5-1.0 feet of flooding (see Section 4.1.2). Both the 10-year and 100-year show flooding of 0.5-1.0 feet in that intersection.

4.1.2 <u>Street Deficiency</u>

Of the nodes which remain flooded in the existing condition, some of these nodes result in street deficiencies while the magnitude of flooding in other nodes do not result in street deficiencies. Streets are defined as being deficient if the max depth at a node/street is greater than the max allowable design protection. The 2D flooding inundation extent was used in conjunction with the 1D hydraulics to determine the street deficiency.

By comparing the magnitude of the maximum depth at each node and the 2D overland flooding which remains flooded in the existing condition with the max allowable depth according to each typical street section, streets are deficient at the following node locations shown on Table 4-1 and Table 4-2.

Table 4-1: Delhi Street Deficiencies Per Max Allowable Flow (100-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
MH-682	1st Street	@ Shelton Street	Local	1.133	0.71
MH-482	3rd Street	@ Sycamore Street	Local	1.127	0.71
MH-504	4th Street	@ French Street	Arterial (100')	1.489	0.83
MH-506	4th Street	@ French Street	Arterial (100')	1.423	0.83
MH-456	4th Street	@ French Street	Arterial (100')	1.304	0.83
Node414	Bush Street	@ 3rd Street	Local	1.028	0.71
CB-102	Bush Street	@ Spurgeon Street	Local	0.914	0.71
Node415	Bush Street	@ 3rd Street	Local	0.807	0.71
MH-487	Civic Center Dr	@ Ross Street	Local	1.5	0.71
MH-579	Cubbon Street	@ Bitch Street	Local	0.812	0.71
Node428	Cypress Ave	N. of Adams Street	Local	1.081	0.71
MH-652	Edinger Ave	W. of Baker Street	Arterial (120')	1.639	0.85
MH-793	Edinger Ave	NE of Maple Street	Arterial (120')	1.23	0.85
MH-679	Flower Street	@ Flower Street	Arterial (100')	1.573	0.83
CB-160	Fruit Street	S. of Santa Ana Blvd	Local	1.805	0.71
Node439	Hood Ave	@ Oak Street	Local	2.278	0.71
MH-693	Main Street	@ 3rd Street	Arterial (120')	0.976	0.85
MH-574	Myrtle Street	@ Main Street	Local	2.367	0.71
MH-446	Penn Way	@ I-5	Local	5.804	0.71
CB-95	Poinsettia Street	NE of Santa Ana Blvd	Local	3.313	0.71
CB-156	Ross Street	NW of Sanpoint Park	Local	0.714	0.71
MH-794	Rouselle Street	@ St. Andrew Pl	Local	1.702	0.71
MH-744	Rouselle Street	@ St. Gertrude Pl	Local	0.88	0.71
MH-586	Rouselle Street	@ Occidental St	Local	0.852	0.71
MH-776	Santa Ana Blvd	@ Garfield Street	Arterial (120')	1.23	0.85
CB-159	Santa Ana Blvd	NE of Lincoln Ave	Arterial (120')	1.165	0.85
MH-676	Santa Ana Blvd	@ Minter Street	Arterial (120')	1.153	0.85
MH-672	Santa Ana Blvd	@ Spurgeon Street	Arterial (120')	1.154	0.85
Node451	Segerstrom Ave	W of Flower Street	Arterial (120')	2.412	0.85
MH-610	Warner Ave	E of Halladay Street	Arterial (120')	1.698	0.85

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
MH-608	Warner Ave	SE of Rouselle Street	Arterial (120')	1.338	0.85
CB-117	Warner Ave	SE of Rouselle Street	Arterial (120')	1.08	0.85
MH-611	Warner Ave	@ Standard Ave	Arterial (120')	1.04	0.85
MH-603	Warner Ave	SE of Rosswood Ave	Arterial (120')	0.891	0.85
CB-176	Woodland Pl	@ Alpine Ave	Local	1.378	0.71

Table 4-2: Delhi Street Deficiencies Per Max Allowable Flow (10-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
MH-682	1st Street	@ Shelton Street	Local	1.003	0.5
MH-482	3rd Street	@ Sycamore Street	Local	0.514	0.5
MH-504	4th Street	@ French Street	Arterial (100')	0.76	0.55
MH-506	4th Street	@ French Street	Arterial (100')	0.695	0.55
MH-456	4th Street	@ French Street	Arterial (100')	0.577	0.55
CB-102	Bush Street	@ 3rd Street	Local	1.081	0.5
Node414	Bush Street	@ Spurgeon Street	Local	0.846	0.5
Node415	Bush Street	@ 3rd Street	Local	0.671	0.5
MH-487	Civic Center Dr	@ Ross Street	Local	1.181	0.5
MH-579	Cubbon Street	@ Bitch Street	Local	0.517	0.5
Node428	Cypress Ave	N. of Adams Street	Local	0.674	0.5
MH-652	Edinger Ave	W. of Baker Street	Arterial (120')	1.512	0.73
MH-793	Edinger Ave	NE of Maple Street	Arterial (120')	1.044	0.73
MH-679	Flower Street	@ Flower Street	Arterial (100')	1.011	0.55
CB-160	Fruit Street	S. of Santa Ana Blvd	Local	1.284	0.5
Node439	Hood Ave	@ Oak Street	Local	2.048	0.5
MH-574	Myrtle Street	@ Main Street	Local	1.278	0.5
MH-446	Penn Way	@ I-5	Local	2.823	0.5
CB-95	Poinsettia Street	NE of Santa Ana Blvd	Local	1.862	0.5
MH-794	Rouselle Street	@ St. Andrew Pl	Local	1.54	0.5
MH-744	Rouselle Street	@ St. Gertrude Pl	Local	0.697	0.5

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
MH-586	Rouselle Street	@ Occidental St	Local	0.67	0.5
MH-776	Santa Ana Blvd	@ Garfield Street	Arterial (120')	0.921	0.73
MH-676	Santa Ana Blvd	@ Minter Street	Arterial (120')	0.808	0.73
Node451	Segerstrom Ave	W of Flower Street	Arterial (120')	2.04	0.73
MH-608	Warner Ave	SE of Rouselle Street	Arterial (120')	1.091	0.73
CB-117	Warner Ave	SE of Rouselle Street	Arterial (120')	0.859	0.73
CB-159	Santa Ana Blvd	NE of Lincoln Ave	Arterial (120')	0.674	0.73
MH-611	Warner Ave	@ Standard Ave	Arterial (120')	0.724	0.73
MH-603	Warner Ave	SE of Rosswood Ave	Arterial (120')	0.703	0.73
MH-610	Warner Ave	E of Halladay Street	Arterial (120')	0.633	0.73

4.1.3 Known Flooding Area and Winter 2017 Storms

City of Santa Ana has known flooding locations within the Delhi watershed. Some of these locations experience flooding during the winter season such as the January 22, 2017 storm. According to some estimates, the storm event was estimated between 10- and 25-year. Flooding locations were observed and documented by the city maintenance crew and some locations were identified based on social media research, i.e., twitter feeds and resident complaints. The flooding locations within the Delhi watershed

Broadway St. and Civic Center Dr. to Broadway St. and W. Washington Ave. (Subarea 20)

On January 12, 2017, there were several complaints regarding severe flooding from Broadway St. and Civic Center Dr. to Broadway St. and W. Washington Ave. Storm drains on both sides of Broadway were unable to handle the flow. Debris from the storm made its way into the storm drain causing heavy flooding unto the sidewalk. Ocean Blue was onsite clearing out the debris allowing easier access of the flooding into the storm drain.

W. Santa Ana Blvd. and N. Ross St. (Subarea 20)

On January 12, 2017, the intersection of W. Santa Ana Blvd and N. Ross St. experienced heavy flooding. Flow accumulated on the Northeast side of the intersection. The storm caused flooding at the intersection and onto the sidewalk. The City responded to several complaints and it was observed that the storm drain was not blocked from any debris but was unable to handle the flow from the severe storm.

Bush Street (4th and 3rd Street) (Subarea 6)

Several complaints have been documented for flooding along 3rd Street. The residents have labelled the flooding as the “Bush River”. Flood waters effected resident homes adjacent to the street.

3rd Street and Bush Street – January 12, 2017

Main St. and 3rd St. (Subarea 21)

January 12, 2017 several complaints were made of heavy flooding at Main St. and 3rd St. The City responded and after arriving at the location no flooding was observed. The flow from the rainfall was flowing into the storm drain.

3rd Street and Main Street – Looking Southeast

S. Rosewood Ave. and W. Richland Ave. (Subarea 25)

January 12, 2017 several complaints were made of heavy flooding on S. Rosewood Ave. and W. Richland Ave. Ocean Blue was on site clearing up debris from that had made its way onto the storm drains at the intersections. The storm caused flooding on the street and made its way partially onto resident's driveway and sidewalk.

S. Poplar St. and W. St. Anne Place (Subarea 35)

January 12, 2017 heavy flooding occurred in a residential area on S. Poplar St. and W. St. Anne Place. Due to heavy rainfall flooding was caused at the intersection. Nearest catch basin at S. Rene Dr. and W. St. Gertrude Pl and Bristol St. and Warner Ave.

S. Bristol St. and Warner Av. (Subarea 35)

January 12, 2017 S. Bristol St. and Warner Ave was flooded. Once at site we were unable to verify the cause of the flooding as no debris or obstructions were witnessed.

Bristol and Warner Street

Edinger Ave. east of Maple St

S. Chestnut Ave. and Halladay St. (Subarea 12)

A crossing guard emailed the City to report flooded water that accumulates on the southeast corner of Chestnut Ave. and Halladay Street.

Segerstrom Ave and Shelton St. (north of the intersection) (Subarea 38)

Signs of ponded water at Shelton and Hemlock (north of the intersection between Segerstrom and Shelton). This is based on the February 19, 2014 storm.

4th St. and French St. (Subarea 4)

This location has been previously indicated by the city to be known to flood based on the SDMP Phase 1 Study.

Sycamore St. (between 3rd St. and 4th St.) (Subarea 21)

This location has been previously indicated by the city to be known to flood based on the SDMP Phase 1 Study.

4.2 Proposed Condition

A description of the proposed improvement areas within the Delhi watershed are discussed below. For a compiled list of proposed improvements, see Table 4-3 and Table 4-4. Figure 4-6 and Figure 4-7 show the 10-year and 100-year proposed condition maximum depth results. Figure 4-8 and Figure 4-9 show the 10-year and 100-year proposed condition duration of inundation maps. Figure 4-10 and Figure 4-11 show the 10-year and 100-year difference (existing vs proposed) depth maps. Figure 4-12 through Figure 4-23 show the proposed facilities.

The Delhi watershed storm drain systems that are deficient have been improved using a combination of addition/upsizing of catch basin inlets and storm drain systems.

Subarea 1

This subarea is the most upstream portion of the eastern drainage system. Upsizing the catch basins along Washington Ave will allow more runoff to enter the sub-surface system. The storm drains along Bush and Spurgeon Street have been upsized from 27-in RCP to 54-in RCP.

Subarea 2

The system along Santa Ana Blvd (future Street Car Alignment) has been upsized to reduce the overland flow.

Subarea 12

This subarea has a system along Maple Street and along McFadden Ave. All runoff is overland flow and is intercepted by the inlets along McFadden Avenue. Three (3) inlets have been proposed to be upsized and the existing 42-in RCP will be upsized to a 8’W x 4’H RCB. Other improvements are along Maple Street which is the main trunk line for the Rouselle System.

Subarea 13/15/6/17/18

Major improvements are along Maple Street which is the main trunk line for the Rouselle System.

Subarea 19

The subarea is tributary to the undersized Warner Avenue storm drain systems. In order to remove the street flooding within Warner Avenue, the existing storm drains and catch basin were extended and upsized to allow more runoff to flow into the sub-surface and less overland on the streets. The storm drain system was upsized to 60-in RCP along Warner Ave. Other improvements are along Maple Street which is the main trunk line for the Rouselle System.

Subarea 30

The existing 21-in to 48-in RCP system along Edinger Avenue is deficient due to the large tributary area. Upsizing the inlets, installing new storm drain and upsizing the existing systems will reduce the surface ponding experienced at this location.

Subarea 33

The Warner Avenue (Rouselle) system is tributary to approximately 1,000 acres and is only a 69-in RCP with a flat (<0.5%) slope. Improving this system is critical in alleviating/reducing flooding upstream of the watershed. The proposed improvement includes installing a Dbl 8'W x 8'H RCB and upsizing the laterals that connect to this reach.

Subarea 38

All the surface runoff that is not captured by the drainage system on the upstream (north) flows south and is intercepted by the systems along Hemlock Way. The existing system is a 60-in RCP. The proposed improvement includes extending storm drain on Lowell Street, Ramona Drive, and Olive Street. The existing system will be upsized to a Dbl 66-in RCP.

4.2.1 Drainage Improvements

4.2.1.1 Delhi Catch Basins

Table 4-3 lists which catch basins are recommended for improvement. Details on existing and proposed catch basin sizes can be found in Appendix F.

Table 4-3: Delhi Proposed Upsized Catch Basins

Sub Area 1
CB-86, CB-87, CB-90
Sub Area 2
CB-94
Sub Area 12
CB-110-, CB-111, CB-109
Sub Area 13
CB-112
Sub Area 14
CB-24, CB-26
Sub Area 15
CB-113
Sub Area 16
CB-114
Sub Area 17
CB-76
Sub Area 18
CB-115
Sub Area 19
CB-35, CB-116, CB-34, CB-117
Sub Area 20
CB-8, CB-118
Sub Area 21
CB-6
Sub Area 22
CB-5, CB-122, CB-4
Sub Area 23
CB-123
Sub Area 25
CB-129
Sub Area 27
CB-130, CB-131, CB-18, CB-21
Sub Area 30
CB-134, CB-135, CB-83, CB-82, CB-81

Sub Area 31
CB-30
Sub Area 32
CB-75
Sub Area 33
CB-85
Sub Area 34
CB-137
Sub Area 35
CB-138
Sub Area 36
CB-139
Sub Area 38
CB-141
Sub Area 40
CB-146
Sub Area 41
CB-148, CB-149
Sub Area 42
CB-147
Sub Area 43
CB-72
Sub Area 44
CB-150
Sub Area 45
CB-74
Sub Area 46
CB-152, CB-151
Sub Area 47
CB-153

4.2.1.2 Delhi Proposed SD Improvements

Table 4-4 lists the recommended storm drain improvements. Details on cost estimates can be found in Appendix C.

Table 4-4: Delhi Proposed Storm Drains

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
W Washington Ave	SADH_108-109_A_EX	18	36	82
W Washington Ave	SADH_109-110_1_EX	21	54	329
W Washington Ave	SADH_105-110_A_EX	15	48	133

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
N Bush St	SADH_110-149_1_EX	27	54	746
E 10th St	SADH_148-149_A_EX	15	24	95
E 10th St	SADH_149-154_1_EX	30	54	298
N Spurgeon St	SADH_149-154_2_EX	30	54	994
Civic Center Dr E	SADH_152-153_A_EX	12	48	57
Civic Center Dr E	SADH_153-154_1_EX	18	48	280
Civic Center Dr E	SADH_153-154_2_EX	18	54	305
N Spurgeon St	SADH_154-159_1_EX	33	54	337
E Santa Ana Blvd	SADH_154-159_2_EX	33	54	305
Sub Area 2				
Penn Way	SADH_117-118_A_EX	24	36	14
Penn Way	SADH_117-118_1_EX	24	36	315
Penn Way	SADH_117-118_2_EX	24	36	235
Penn Way	SADH_117-118_3_EX	24	36	355
Penn Way	SADH_117-118_4_EX	24	36	33
N Santiago St	SADH_118-126_2_EX	27	48	708
N Santiago St	SADH_118-126_3_EX	27	48	292
N Santiago St	SADH_118-126_4_EX	27	48	295
E Santa Ana Blvd	SADH_126-131_1_EX	27	54	378
E Santa Ana Blvd	SADH_131-135_1_EX	27	54	383
E Santa Ana Blvd	SADH_135-139_1_EX	27	54	392
E Santa Ana Blvd	SADH_139-142_1_EX	27	54	408
E Santa Ana Blvd	SADH_142-159_1_EX	27	54	695
Sub Area 4				
French St	SADH_159-166_1_EX	39	60	641
Sub Area 5				
French St	SADH_166-169_1_EX	39	60	366
Sub Area 7				
French St	SADH_169-187_1_EX	39	60	583
E 1st St	SADH_169-187_2_EX	39	60	35
E 1st St	SADH_169-187_3_EX	39	60	329
E 1st St	SADH_169-187_4_EX	39	60	35
Sub Area 9				
S Standard Ave	SADH_199.5-200_A_EX	18	24	93
Sub Area 10				
Maple St	SADH_187-204_1_EX	39	60	336
Maple St	SADH_204-209_1_EX	48	DBL 60	700
Maple St	SADH_209-214_1_EX	48	DBL 60	58
Sub Area 11				

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
S Main St	SADH_212-213_A_EX	24	DBL 18	169
E Myrtle St	SADH_213-214_1_EX	24	DBL 24	392
E Myrtle St	SADH_213-214_2_EX	24	48	440
E Myrtle St	SADH_213-214_3_EX	24	48	421
Sub Area 12				
Maple St	SADH_209-214_2_EX	48	DBL 60	305
Maple St	SADH_214-230_1_EX	48	DBL 60	1529
Maple St	SADH_214-230_2_EX	48	DBL 60	1345
Maple St	SADH_214-230_3_EX	51	DBL 60	82
S Standard Ave	SADH_218-219_A_EC	18	8'x3' RCB	107
E McFadden Ave	SADH_219-224_1_EX	36	8'x4' RCB	694
Cedar St	SADH_223-224_A_EX	18	36	90
E McFadden Ave	SADH_224-229_1_EX	36	8'x4' RCB	234
S Halladay St	SADH_228-229_A_EX	18	48	115
E McFadden Ave	SADH_229-230_1_EX	42	8'x4' RCB	590
E McFadden Ave	SADH_229-230_2_EX	42	8'x4' RCB	579
Sub Area 13				
Pacific Electric Bicycle Trail	SADH_230-246_2_EX	51	DBL 60	1282
Hobart St	SADH_236-246_1_EX	24	48	388
Sub Area 14				
S Main St	SADH_239-240_A_EX	24	8'x2.5' RCB	49
Hobart St	SADH_240-245_1_EX	24	8'x2.5' RCB	401
Hobart St	SADH_240-245_2_EX	27	8'x3.5' RCB	397
Hobart St	SADH_245-246_1_EX	36	8'x4' RCB	489
Sub Area 15				
Pacific Electric Bicycle Trail	SADH_246-252_1_EX	51	DBL 60	1078
E Edinger Ave	Link534	24	36	272
E Edinger Ave	SADH_251-252_1_EX	39	DBL 39	220
E Edinger Ave	SADH_250-251_A_EX	39	DBL 39	79
Sub Area 16				
Pacific Electric Bicycle Trail	SADH_252-257_1_EX	51	10'x6' RCB	1301
Rouselle St	SADH_252-257_2_EX	51	10'x6' RCB	333
E St Andrew Pl	SADH_256-257_A_EX	12	48	20
E St Andrew Pl	SADH_256-257_1_EX	12	48	21
Sub Area 17				
Rouselle St	SADH_257-262_1_EX	51	10'x6' RCB	990
E St Gertrude Pl	SADH_261-262_1_EX	12	36	340
Sub Area 18				
Rouselle St	SADH_262-265_1_EX	51	10'x6' RCB	681

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
E Anahurst Pl	SADH_264-265_1_EX	12	48	109
Sub Area 19				
S Standard Ave	Link560*	-	60	1306
S Standard Ave	SADH_269-270_A_EX	18	60	20
S Standard Ave	Link549*	-	60	50
E Warner Ave	SADH_270-274_1_EX	27	60	376
Evergreen St	SADH_273-274_A_EX	27	36	116
E Warner Ave	SADH_274-281_1_EX	27	60	618
S Halladay St	SADH_280-281_A_EX	18	36	20
E Warner Ave	SADH_281-285_1_EX	27	60	1108
E Warner Ave	SADH_281-285_A_EX	24	36	102
E Warner Ave	Link558*	24	60	50
Rouselle St	SADH_265-285_1_EX	51	10'x6' RCB	633
Sub Area 20				
Civic Center Dr E	SADH_289-293_2_EX	21	36	427
Civic Center Dr E	SADH_289-293_3_EX	21	36	410
Civic Center Dr E	SADH_292-293_A_EX	18	36	134
N Ross St	SADH_293-299_1_EX	24	6'x2' RCB	629
N Ross St	SADH_293-299_2_EX	24	6'x2' RCB	349
N Ross St	SADH_299-307_1_EX	24	6'x3' RCB	379
Sub Area 21				
N Ross St	SADH_299-307_2_EX	24	6'x3' RCB	266
N Ross St	SADH_299-307_3_EX	24	6'x3' RCB	28
W 3rd St	SADH_307-320_1_EX	33	10'x4' RCB	268
N Main St	SADH_295-296_A_EX	18	DBL 18	50
W 3rd St	SADH_296-306_1_EX	21	DBL 36	306
W 3rd St	SADH_296-306_A_EX	21	30	28
W 3rd St	SADH_296-306_2_EX	21	DBL 36	315
W 3rd St	SADH_306-307_1_EX	24	DBL 36	877
Sub Area 22				
West of N Ross St	SADH_320-326_1_EX	36	10'x4' RCB	483
W 1st St	SADH_320-326_2_EX	36	10'x4' RCB	341
Flower Street Park	SADH_320-326_3_EX	33	10'x4' RCB	384
Flower Street Park	SADH_320-326_4_EX	33	10'x4' RCB	35
Flower Street Park	SADH_320-326_5_EX	33	10'x4' RCB	106
Flower Street Park	SADH_320-326_6_EX	33	10'x4' RCB	35
N Flower St	SADH_312-316_1_EX	33	48	350
N Flower St	SADH_312-316_2_EX	33	48	370
N Flower St	SADH_312-316_3_EX	33	48	490

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
N Flower St	SADH_312-316_4_EX	33	48	70
N Flower St	SADH_316-325_1_EX	33	54	406
N Flower St	SADH_316-325_2_EX	33	54	409
N Flower St	SADH_316-325_3_EX	33	54	55
N Flower St	SADH_325-326_1_EX	33	66	384
Sub Area 23				
W Civic Center Dr	SADH_330-333_2_EX	27	36	270
W Civic Center Dr	SADH_330-333_3_EX	27	36	303
W Civic Center Dr	SADH_330-333_4_EX	27	42	251
W Civic Center Dr	SADH_330-333_5_EX	27	42	137
N Shelton St	SADH_330-333_6_EX	27	48	601
W 6th St	SADH_330-333_7_EX	27	48	143
N Shelton St	SADH_330-333_9_EX	27	48	48
N Shelton St	SADH_330-333_10_EX	27	48	254
N Shelton St	SADH_330-333_11_EX	27	48	66
N Shelton St	SADH_330-333_12_EX	27	48	259
N Shelton St	SADH_333-337_1_EX	30	48	626
N Shelton St	SADH_333-337_2_EX	30	48	260
S Shelton St	SADH_337-340_1_EX	30	48	150
S Shelton St	SADH_337-340_2_EX	30	48	686
W Pine St	SADH_326-341_2_EX	33	10'x6' RCB	1293
S Shelton St	SADH_340-341_1_EX	42	10'x6' RCB	597
S Shelton St	SADH_341-348_1_EX	42	10'x6' RCB	901
W Civic Center Dr	SADH_329-330_A_EX	27	36	52
Sub Area 24				
W Bishop St	Link529*	-	21	92
Sub Area 25				
Richland Ave	SADH_351-352_1_EX	18	42	269
Sub Area 26				
S Shelton St	SADH_348-352_1_EX	45	10'x6' RCB	452
S Shelton St	SADH_352-356_1_EX	45	10'x6' RCB	1316
McFadden Ave	SADH_352-356_2_EX	48	10'x6' RCB	37
McFadden Ave	SADH_352-356_3_EX	48	10'x6' RCB	49
McFadden Ave	SADH_356-381_1_EX	48	10'x6' RCB	300
McFadden Ave	SADH_380-381_4_EX	36	72	920
McFadden Ave	SADH_380-381_3_EX	36	72	35
S Flower St	SADH_380-381_2_EX	36	72	429
Sub Area 27				
W Cubbon St	SADH_360-361_A_EX	12	36	70

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
W Cubbon St	SADH_361-366_1_EX	18	54	249
W Cubbon St	SADH_365-366_A_EX	24	48	74
W Cubbon St	SADH_366-371_1_EX	24	54	304
W Cubbon St	SADH_366-371_2_EX	27	54	365
W Cubbon St	SADH_370-371_A_EX	27	48	11
W Cubbon St	SADH_371-375_1_EX	30	54	403
W Cubbon St	SADH_371-375_2_EX	30	54	334
W Cubbon St	SADH_371-375_3_EX	33	60	310
W Cubbon St	SADH_374-375_A_EX	27	48	11
W Cubbon St	SADH_375-380_1_EX	33	60	307
W Cubbon St	SADH_375-380_2_EX	33	60	301
W Cubbon St	SADH_379-380_A_EX	30	48	72
W Cubbon St	SADH_380-381_1_EX	36	72	70
S Flower St	SADH_326-341_1_EX	33	10'x6' RCB	333
Sub Area 28				
S Towner St	SADH_381-390_1_EX	54	14'x6' RCB	1291
W Wilshire Ave	SADH_389-390_1_EX	30	54	348
W Wilshire Ave	SADH_388-389_A_EX	30	48	92
W Wilshire Ave	SADH_385-389_1_EX	30	48	1244
W Wilshire Ave	SADH_384-385_A_EX	30	48	41
Sub Area 29				
S Towner St	SADH_390-399_1_EX	57	14'x6' RCB	1215
W Edinger Ave	SADH_399-430_1_EX	63	14'x6' RCB	974
S Towner St	SADH_390-399_2_EX	57	14'x6' RCB	73
W Edinger Ave	SADH_394-398_2_EX	33	36	325
W Edinger Ave	SADH_394-398_1_EX	24	36	349
W Edinger Ave	SADH_393-394_A_EX	24	36	6
Sub Area 30				
S Flower St	SADH_430-435_1_EX	66	14'x6.5' RCB	56
W Edinger Ave	SADH_421-430_2_EX	48	66	160
W Edinger Ave	SADH_421-430_1_EX	48	66	494
W Edinger Ave	SADH_416-421_1_EX.1	48	66	325
W Edinger Ave	SADH_416-421_1_EX	48	66	325
W Edinger Ave	SADH_411-416_1_EX	42	66	780
W Edinger Ave	SADH_410-411_A_EX	36	48	2
W Edinger Ave	SADH_406-411_1_EX	36	66	535
W Edinger Ave	SADH_405-406_A_EX	36	42	141
W Edinger Ave	SADH_402-406_3_EX	30	48	478
W Edinger Ave	SADH_402-406_2_EX	27	42	396

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
W Edinger Ave	SADH_402-406_1_EX	21	36	341
S Main St	Link557.1*	-	48	70
S Main St	Link557*	-	48	899
W Edinger Ave	Link562*	-	36	67
Sub Area 31				
S Flower St	SADH_430-435_2_EX	66	14'x6.5' RCB	1636
W St Andrew Pl	SADH_434-435_1_EX	12	36	25
Sub Area 32				
S Flower St	SADH_435-440_1_EX	66	14'x6.5' RCB	937
E St Gertrude Pl	SADH_439-440_1_EX	27	48	25
Sub Area 33				
Warner Ave	Link559*	-	8'x8' RCB	714
Orange Ave	Link564*	-	60	552
Orange Ave	Link565*	-	60	213
Warner Ave	Link559.1*	-	8'x8' RCB	714
Warner Ave	SADH_451-469_1_EX	69	DBL 8'x8' RCB	137
Warner Ave	SADH_451-469_2_EX	69	DBL 8'x8' RCB	781
Warner Ave	SADH_451-469_3_EX	69	DBL 10'x8' RCB	1216
Warner Ave	SADH_451-469_4_EX	69	DBL 12'x8' RCB	67
Warner Ave	Link532	-	18	33
Warner Ave	Link533	-	18	33
S Main St	Link545	-	48	102
S Main St	Link546	-	48	138
S Flower St	SADH_455-469_1_EX	66	DBL 14'x6.5' RCB	655
Sub Area 34				
S Flower St	SADH_440-455_1_EX	66	14'x6.5' RCB	647
W Anahurst Pl	SADH_454-455_1_EX	12	48	25
Sub Area 35				
S Bristol St	Link556*	-	48	714
S Rosewood Ave	Link574*	-	60	1184
West of Memorial Park	Link569*	-	54	660
W Anahurst Pl	Link570*	-	54	465
S Lowell St	Link572*	-	60	671
S Bristol St	SADH_458-459_A_EX	12	DBL 42	134
W Warner Ave	SADH_459-463_1_EX	42	DBL 10'x6' RCB	792
W Warner Ave	SADH_462-463_A_EX	36	60	25
W Warner Ave	SADH_463-469_1_EX	42	DBL 10'x6' RCB	1200
W Warner Ave	SADH_467-468_A_EX	36	72	25
W Warner Ave	SADH_463-469_2_EX	42	DBL 10'x6' RCB	600

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
S Flower St	SADH_469-479_1_EX	8'x6' RCB	14'x6.5' RCB	668
Sub Area 36				
S Flower St	SADH_469-479_2_EX	8'x6' RCB	14'x6.5' RCB	15
W Central Ave	SADH_474-479_1_EX	24	48	124
W Central Ave	Link530*	-	42	253
W Central Ave	Link531*	-	48	352
Sub Area 38				
Ramona Dr	Link540*	-	66	759
S Lowell St	Link554*	-	66	792
S Olive St	Link555*	-	66	772
W Segerstrom Ave	SADH_484-487_1_EX	54	DBL 66	296
W Segerstrom Ave	SADH_484-487_2_EX	57	DBL 66	260
S Lowell St	Link528*	-	66	79
Ramona Dr	SADH_486-487_A_EX	57	66	76
W Segerstrom Ave	SADH_487-488_1_EX	57	DBL 66	275
S Olive St	Link543*	-	66	79
S Olive St	Link542*	-	36	37
W Segerstrom Ave	SADH_487-488_2_EX	60	DBL 66	202
S Sycamore St	Link547*	-	24	62
Sub Area 40				
Railroad N of Dickens Pl	SADH_521-522_2_EX	84	DBL 66	974
Sub Area 41				
Bradford Pl	SADH_530.5-531_A_EX	54	60	81
Bradford Pl	Link552*	-	60	643
W Alton Ave	SADH_531-534_1_EX	54	DBL 60	592
W Alton Ave	SADH_531-534_2_EX	60	DBL 60	65
Sub Area 42				
W Alton Ave	SADH_533-534_1_EX	24	48	143
Sub Area 44				
W Columbine Ave	SADH_546.4-547_1_EX	30	54	76
Sub Area 45				
S Woodland Pl	SADH_554-555_1_EX	42	7'x7' RCB	143
Sub Area 46				
W MacArthur Blvd	SADH_560-564_1_EX	36	42	646
W MacArthur Blvd	SADH_560-564_2_EX	42	48	548
W MacArthur Blvd	SADH_564-568_1_EX	51	66	711
W MacArthur Blvd	SADH_564-568_2_EX	51	72	615
W MacArthur Blvd	SADH_568-569_1_EX	42	72	39
W MacArthur Blvd	SADH_568-569_2_EX	42	72	895

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
Sub Area 47				
W MacArthur Blvd	SADH_573-577_2_EX	33	48	82
W MacArthur Blvd	SADH_577-578_1_EX	36	6'x4' RCB	134
Sub Area 48				
N of Aurora Ave	SADH_580-581_A_EX	21	36	173
N of Aurora Ave	SADH_581-582_1_EX	27	36	275
N of Aurora Ave	SADH_582-583_1_EX	33	36	438
Murphy Ave	SADH_583-584_1_EX	42	84	431

4.2.1.3 Bristol Street and Streetcar Improvements

Bristol Street Improvements are scheduled to be in construction until the end of 2018. The project will consist of widening Bristol Street from four lanes to six lanes, adding a bike lane on either side of the roadway, and widening the sidewalks. The improvements will increase safety, reduce traffic, and improve storm water drainage. The current improvements are Civic Center Dr to Washington Ave (final design phase), Washington Ave to 17th St (design phase), and Warner Ave to Saint Andrew Pl (final design phase).

The Santa Ana – Garden Grove Streetcar improvement project is currently in the design phase and is scheduled to be in construction through 2019 and begin operation in 2020. The project will develop a last-mile connection from the Santa Ana Regional Transportation Center to Garden Grove, which will allow greater mobility for Santa Ana and Garden Grove residents.

Improvements will include the addition of several culvert systems designed to carry flow under the proposed railroad system as well as some minor storm drain additions to redirect flow to existing storm drain systems.

4.3 Cost Estimates

Cost estimates have been completed for all proposed improvements in the 10-year condition. The grouping of all sub areas remains consistent with the grouping within the proposed facilities exhibits.

Table 4-5 shows the proposed storm drain cost estimate summary. For detailed cost estimates see Appendix C.

Table 4-5: Delhi Proposed Storm Drain Cost Estimate

Delhi Proposed Storm Drain Cost Estimate	
Sub Areas	**Total Project Cost**
1 – 3	$5,908,000
4 – 11	$4,224,000
12 – 15	$14,595,000
16 – 19	$16,816,000
20 – 23	$19,761,000
24 – 27	$12,314,000
28 – 31	$27,338,000

32 - 35	$41,328,000
36 – 40	$6,366,000
41 – 46	$5,075,000
47 - 58	$1,228,000
Total	**$154,953,000**

5 Gardens Watershed

The Santa Ana Gardens Watershed has a drainage area of approximately 4.4 sq. miles. The watershed is entirely within the City of Santa Ana. The watershed is bounded by Washington Ave. to the north, and Sunflower Ave. to the South. The watershed includes a drainage system that drains to the Orange County Flood Control District Santa Ana Gardens Channel (OCFCD Facility No. F02). The channel headworks is at 1st street.

The Gardens Channel is a graded earthen channel to Alton Avenue. Downstream of Alton Avenue, the channel is a reinforced rectangular concrete section. Gardens Channel confluences with the Delhi Channel at Sunflower Avenue and continues flowing south towards upper Newport Bay.

5.1 Existing Condition

The existing condition flood routing analyses were performed to identify existing street surface conveyance and storm drain capacities and to acquire a benchmark for the proposed analyses. The 10- and 100-year annual chance models were then calculated to develop a basis for the evaluation and development of potential drainage improvements.

In this study, the following updates were made to the SDMP Phase 1 hydrology delineation and/or storm drain geometry. This update/revision is to further define the drainage patterns. Figure 5-1 shows the Gardens watershed subarea map.

Subarea 1

1. SAGC_103-109_A_EX size reduced to 30 in from 54 in according to the capacity of the combined laterals.
2. Split flows going into CB-26 into eight catch basins. The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.

Subarea 14

1. Split flows tributary into CB-53 into the four existing catch basins (CB-51 through CB-54) that were included in the Phase 1 study. The catch basins were verified in Google Earth. The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.
2. Split flows tributary into CB-40 into nine existing catch basins (CB-40 through CB-48). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in Google Earth.

Subarea 16

1. Split flows tributary into CB-64 into three existing catch basins (CB-62 through CB-64). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.
2. Split flows tributary into CB-61 into three existing catch basins (CB-59 through CB-61). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.

Subarea 29

1. Split flows tributary into CB-282 into two existing catch basins (CB-282 and 283). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the as-builts.

Subarea 30

1. Split flows equally tributary to CB-82 into eight existing catch basins (CB-82, 83, 84, 85, 86, 87, 88, 89). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.
2. Split flows tributary to CB-249 into four existing catch basins (CB-245, 246, 248, 249). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in Google Earth.
3. SAGC_387-304_2_EX changed to a double barrel. The Gardens Channel RCB Culvert under Segerstrom Avenue was input as a single barrel. As-built drawings indicate that this culvert is a double barrel.

Subarea 34

1. SAGC_347-384_1_EX changed to a double barrel. The Gardens Channel RCB Culvert under Alton Avenue was input as a single barrel. As-built drawings indicate that this culvert is a double barrel.

Subarea 37

1. Split flows tributary to CB-275 into two existing catch basins (CB-275, 276). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.

Subarea 39

1. Split flows tributary CB-92 into two existing catch basins (CB-92, 93). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.
2. Split flows going into CB-94 into two existing catch basins (CB-94,95). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.
3. Split flows going into CB-96 into two existing catch basins (CB-96,97). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.
4. Split flows going into CB-98 into two existing catch basins (CB-97,98). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.

Subarea 40

1. Split flows tributary to CB-144 into eight existing catch basins (CB-143, 144, 145, 151, 147, 148, 149, 150). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.
2. SAGC_389-380_2_EX and SAGC_380-375_1_EX changed to a triple barrel. The Gardens Channel RCB Culvert under MacArthur Boulevard and South Coast Plaza was input as a single and double barrel. As-built drawings indicate that this culvert is a triple barrel.

3. Split flows tributary to CB-133 into four existing catch basins (CB-132 through 135). The inlet capture curves for each of these catch basins were calculated based on actual size as determined in the Phase 1 study.

Gardens Channel Tailwater

The tailwater elevation for Gardens Channel was determined with detailed 1D hydraulic analysis using HEC-RAS software. The limits of the hydraulic model were from 1st Street to the 55 Freeway. The 100-year design flow rate (2,050 cfs) shown on the Gardens Channel drawing number F02-701-1-A was used in this analysis. The 10-year design flow rate was determined by calculating a ratio of the 10-year flow rate (260 cfs) and 100-year flow rate (650) in the effective FEMA Flood Insurance Study (FIS) for Gardens Channel and applying this ratio to the design 100-year flow rate from the Gardens Channel as-built.

Based on this detailed hydraulic analysis the 10-year tailwater was 23.4-ft and 26.4-ft for the 100-year storm event. In the SDMP Phase 1 study the tailwater was calculated to be 24.4 ft (10-year) and 26.2 ft (100-year) using normal depth equations.

The HEC-RAS results can be found in Appendix E.

5.1.1 Existing Condition Results

A description of the major flooding areas within the Gardens watershed shown in the 10-year and 100-year existing models are discussed below. Figure 5-2 and Figure 5-3 show the 10-year and 100-year existing condition maximum depth results. Figure 5-4 and Figure 5-5 show the 10-year and 100-year existing condition duration of inundation maps.

Subarea 17 & 20

In the 10-year scenario, the area in the vicinity of the intersection of Raitt Street and Occidental Street experiences 1 to 2 ft. of flooding. The flooding is caused by two deficiencies. The catch basins and main line along Center Street and Edinger Avenue west of Gardens Channel are undersized, causing overflow to travel south before settling in the sump area near Occidental Street. Additionally, the Gardens Channel is unable to fully convey the 10-year flow in this area. Any additional flow that cannot be conveyed in the channel flows along the streets instead of in the channel.

Subarea 20

The neighborhood east of Raitt Street and south of St Andrew Place has sump areas that flood to a depth of 1 to 2 ft. in the 10-year scenario. The lack of capacity within Gardens Channel as previously discussed is the driving factor for these issues. The water surface elevation within the channel is higher than the ground elevation within the neighborhood. Therefore, when the channel is flowing full, water will surcharge and flow out of the storm drain system along Glennwood Place and Forest Avenue. Additionally, the system within Glennwood Place is undersized and unable to convey flow from along Raitt Street.

Subarea 21

Rene Drive on the east side of Gardens Channel south of St Andrew Place experiences flooding due to the previously discussed capacity issues within the channel.

Subarea 22

The short storm drain systems within St Gertrude Place (west of Gardens Channel) is undersized and unable to carry flow from the residential area.

Subarea 24

The storm drain along Warner Avenue (east of Gardens channel) is also undersized and unable to convey flow from within the neighborhood area.

Subarea 27

High water surface elevations within Gardens Channel adjacent to Carl Thornton Park and south of Segerstrom Avenue cause the systems within the park to surcharge. This results in excess water to runoff of the park and continue south along Bear Street, causing flooding within the neighborhood. The high tailwater within the channel at Segerstrom Avenue also reduces the capacity of the system to the east of the channel along Segerstrom Avenue. Overflow from this system flows southward along Spruce Street, resulting in flooding along Rene Drive, Rita Way, and Carriage Drive.

Subarea 39

Catch basins that are tributary to the storm drain system within Towner Street are undersized for the 10-year scenario, resulting in minor flooding throughout this neighborhood. Overflow from these catch basins flows south into MacArthur Boulevard, causing 1- to -2 ft of flooding that overflows into Rosewood Avenue and Orion Avenue.

5.1.1.1 Gardens Model Validation

The Gardens model was validated by comparing flooding at the intersection of Baker St and St Andrews Pl. Photos were taken at the intersection during the January 12, 2017 storm showing 0.5-1.0 feet of flooding (see Section 5.1.2). This storm, according to some estimates was between a 10- and 25-year storm event. Both the 10-year and 100-year show flooding of 0.5-1.0 feet in that intersection.

5.1.2 Street Deficiency

Of the nodes which remain flooded in the existing condition, some of these nodes result in street deficiencies while the magnitude of flooding in other nodes do not result in street deficiencies. Streets are defined as being deficient if the max depth at a node/street is greater than the max allowable design protection. The 2D flooding inundation extent was used in conjunction with the 1D hydraulics to determine the street deficiency.

By comparing the magnitude of the maximum depth at each node and the 2D overland flooding which remains flooded in the existing condition with the max allowable depth according to each typical street section, streets are deficient at the following node locations shown on Table 5-1 and Table 5-2.

Table 5-1: Garden Street Deficiencies Per Max Allowable Flow (100-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
`	1st Street	@ Townsend Street	Local	0.804	0.71
CB-229	Adams Street	@ Rene Dr	Local	2.404	0.71
CB-283	Adams Street	@ Rene Dr	Local	0.752	0.71
CB-134	Bay Crest Street	@ Sea Breeze	Local	1.047	0.71
MH-238	Bay Crest Street	end of Cul-de-Sac	Local	0.814	0.71
CB-111	Bear Street	S of Alton Ave	Local	1.253	0.71

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
CB-284	Bear Street	S of Alton Ave	Local	1.17	0.71
MH-191	Bear Street	@ Garry Ave	Local	0.941	0.71
CB-168	Center St	S of Mark Street	Local	1.062	0.71
CB-68	Chandler Ave	@ Criset Pl	Local	2.207	0.71
CB-69	Chandler Ave	@ Criset Pl	Local	2.09	0.71
CB-73	Chandler Ave	@ Townsend Street	Local	1.4	0.71
CB-74	Chandler Ave	@ Townsend Street	Local	2.507	0.71
CB-162	Chestnut Ave	@ Center Street	Local	2.951	0.71
CB-165	Duchess Lane	E of Duke Lane	Local	0.938	0.71
MH-179	Duchess Lane	E of Duke Lane	Local	5.662	0.71
MH-420	Edinger Ave	@ Center Street	Arterial (120')	0.927	0.85
MH-65	Edinger Ave	@ Center Street	Arterial (120')	1.032	0.85
MH-76	Edinger Ave	@ Joane Way	Arterial (120')	1.072	0.85
T-4	Edinger Ave	W of Joane Way	Arterial (120')	2.126	0.85
T-5	Edinger Ave	W of Joane Way	Arterial (120')	1.522	0.85
CB-10	English Street	@ Civic Center Dr	Local	2.234	0.71
CB-9	English Street	@ Civic Center Dr	Local	2.415	0.71
CB-252	Garry Ave	@ Bear Street	Local	0.933	0.71
CB-253	Garry Ave	@ Bear Street	Local	1.303	0.71
CB-169	Mark St	@ Center Street	Local	1.733	0.71
CB-260	Moore Ave	@ Rene Dr	Local	1.133	0.71
CB-261	Moore Ave	@ Rene Dr	Local	2.351	0.71
CB-19	N Raitt St	@ 1st Street	Local	1.578	0.71
CB-160	Pacific Ave	@ Myrtle St	Local	5.239	0.71
CB-164	Princess Lane	@ Duchess Ln	Local	0.907	0.71
CB-249	Rene St	@ Segerstorm Ave	Local	1.232	0.71
CB-250	Rene St	@ Carriage Dr	Local	1.651	0.71
CB-251	Rene St	@ Carriage Dr	Local	2.024	0.71
CB-257	Rita way	S of Carriage Dr	Local	2.755	0.71
MH-140	Sea Breeze	@ Bay Crest St	Local	1.382	0.71
CB-119	Sheffield Rd	N of Armstrong Ranch Rd	Local	1.053	0.71
MH-123	Sheffield Rd	N of Armstrong Ranch Rd	Local	1.612	0.71
CB-246	Spruce Street	N of Segerstrom Ave	Local	0.929	0.71
CB-245	W Segerstorm Ave	E of Spruce Street	Arterial (120')	1.719	0.85
CB-247	W Segerstorm Ave	@ Spruce Street	Arterial (120')	1.513	0.85
CB-248	W Segerstorm Ave	W of Spruce Street	Arterial (120')	1.764	0.85
CB-89	W Segerstorm Ave	W of Spruce Street	Arterial (120')	1.929	0.85
MH-100	W Segerstorm Ave	W of Spruce Street	Arterial (120')	1.948	0.85
MH-172	W Segerstorm Ave	E of Spruce Street	Arterial (120')	1.259	0.85

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
MH-173	W Segerstorm Ave	@ Spruce Street	Arterial (120')	1.806	0.85
MH-174	W Segerstorm Ave	W of Spruce Street	Arterial (120')	1.506	0.85
MH-94	W Segerstorm Ave	W of Bristol Street	Arterial (120')	1.118	0.85
MH-97	W Segerstorm Ave	W of Bristol Street	Arterial (120')	0.962	0.85
MH-98	W Segerstorm Ave	E of Spruce Street	Arterial (120')	1.541	0.85
MH-99	W Segerstorm Ave	@ Spruce Street	Arterial (120')	1.297	0.85
CB-189	W Wilshire Ave	@ Raitt Street	Local	0.897	0.71

Table 5-2: Garden Street Deficiencies Per Max Allowable Flow (10-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
CB-10	English Street	@ Civic Center Dr	Local	1.206	0.5
CB-134	Bay Crest Street	@ Sea Breeze	Local	0.831	0.5
CB-16	Hawley Street	@ 5th Street	Local	1.496	0.5
CB-160	Pacific Ave	@ Myrtle St	Local	3.01	0.5
CB-169	Mark St	@ Center Street	Local	1.038	0.5
CB-181	Townsend Street	E of Garden Channel	Local	1.477	0.5
CB-184	McFadden Ave	@ Garden Channel	Arterial (120')	0.759	0.73
CB-189	W Wilshire Ave	@ Raitt Street	Local	0.736	0.5
CB-190	Townsend Street	N of Wilshire Ave	Local	1.157	0.5
CB-195	Elder Ave	@ Raitt Street	Local	0.969	0.5
CB-196	Elder Ave	@ Raitt Street	Local	1.076	0.5
CB-203	Raitt Street	W of Garden Channel	Local	0.769	0.5
CB-206	Occidental Street	E of Garden Channel	Local	1.284	0.5
CB-208	Occidental Street	N of Garden Channel	Local	1.484	0.5
CB-210	Forest Ave	@ Glenwood Pl	Local	1.602	0.5
CB-211	Rene Dr	N of St Gertrude Pl	Local	0.828	0.5
CB-212	Rene Dr	N of St Gertrude Pl	Local	1.017	0.5
CB-213	Forest Ave	@ Forest Ave	Local	0.952	0.5
CB-216	Forest Ave	@ Pendelton Ave	Local	0.853	0.5
CB-229	Adams Street	@ Rene Dr	Local	1.154	0.5
CB-245	W Segerstorm Ave	E of Spruce Street	Arterial (120')	0.937	0.73
CB-247	W Segerstorm Ave	@ Spruce Street	Arterial (120')	1.385	0.73
CB-248	W Segerstorm Ave	W of Spruce Street	Arterial (120')	1.547	0.73
CB-249	Rene St	@ Segerstorm Ave	Local	1.034	0.5
CB-250	Rene St	@ Carriage Dr	Local	1.047	0.5
CB-251	Rene St	@ Carriage Dr	Local	1.593	0.5

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
CB-252	Garry Ave	@ Bear Street	Local	1.255	0.5
CB-253	Garry Ave	@ Bear Street	Local	1.876	0.5
CB-254	Thornton Street	E of Bear Street	Local	0.988	0.5
CB-255	Thornton Street	E of Bear Street	Local	0.67	0.5
CB-257	Rita way	S of Carriage Dr	Local	2.277	0.5
CB-282	Adams Street	E of Rene Dr	Local	0.828	0.5
CB-68	Chandler Ave	@ Criset Pl	Local	0.664	0.5
CB-69	Chandler Ave	@ Criset Pl	Local	0.533	0.5
CB-73	Chandler Ave	@ Townsend Street	Local	0.846	0.5
CB-74	Chandler Ave	@ Townsend Street	Local	2.124	0.5
CB-89	W Segerstorm Ave	W of Spruce Street	Arterial (120')	1.769	0.73
CB-9	English Street	@ Civic Center Dr	Local	1.946	0.5
MH-100	W Segerstorm Ave	W of Spruce Street	Arterial (120')	1.755	0.73
MH-140	Sea Breeze	@ Bay Crest St	Local	1.141	0.5
MH-173	W Segerstorm Ave	@ Spruce Street	Arterial (120')	1.448	0.73
MH-174	W Segerstorm Ave	W of Spruce Street	Arterial (120')	1.276	0.73
MH-191	Bear Street	@ Garry Ave	Local	1.414	0.5
MH-192	Thornton Street	E of Bear Street	Local	1.322	0.5
MH-50	St Andrew Pl	@ Rene Dr	Local	2.228	0.5
MH-51	St Andrew Pl	@ Rene Dr	Local	2.159	0.5
MH-80	Griset Place	@ Chandler Ave	Local	0.623	0.5
MH-85	Chandler Ave	@ Townsend Street	Local	1.623	0.5
MH-87	W Segerstorm Ave	E of Raitt Street	Arterial (120')	1.729	0.73
MH-94	W Segerstorm Ave	W of Bristol Street	Arterial (120')	0.891	0.73
MH-97	W Segerstorm Ave	W of Bristol Street	Arterial (120')	0.786	0.73
MH-98	W Segerstorm Ave	E of Spruce Street	Arterial (120')	1.349	0.73
MH-99	W Segerstorm Ave	@ Spruce Street	Arterial (120')	1.099	0.73
T-3	St Andrew Pl	@ Rene Dr	Local	2.128	0.5

5.1.3 Known Flooding Area and Winter 2017 Storms

Civic Center Dr. and Raitt St.

On December 22nd, 2016 flooding was observed on Civic Center Drive and Raitt Street.

Civic Center Dr and Raitt St – December 22, 2016 Storm

5th St. and Raitt St.

On December 22nd, 2016 flooding was observed on 5th St and Raitt Street.

5th St and Raitt St – December 22, 2016 Storm

Baker St. and St Andrew Pl.

On December 22nd, 2016 flooding was observed on the corner of Baker St and St Andrew Pl.

Baker St and St Andrew Pl – December 22, 2016 Storm

Segerstrom Ave. and Bear St.

This location has been previously indicated by the city to be known to flood based on the SDMP Phase 1 Study.

Segerstrom Ave. and Shelton St.

This location has been previously indicated by the city to be known to flood based on the SDMP Phase 1 Study.

S Poplar St. and St. Anne Pl.

This location has been indicated by the city maintenance team to be known to flood.

5.2 Proposed Condition

A description of the proposed improvement areas within the Gardens watershed are discussed below. For a compiled list of proposed improvements, see Table 5-3 and Table 5-4. Figure 5-6 and Figure 5-7 show the 10-year and 100-year proposed condition maximum depth results. Figure 5-8 and Figure 5-9 show the 10-year and 100-year proposed condition duration of inundation maps. Figure 5-10 and Figure 5-11 show the 10-year and 100-year difference (existing vs proposed) depth maps. Figure 5-12 through Figure 5-17 show the proposed facilities.

Gardens Channel is undersized for approximately 8,800 feet from Edinger Avenue to Alton Avenue. Converting this reach to an uncovered rectangular channel increases the capacity while keeping the channel within the same horizontal extents. The culverts within the Channel underneath the roadways are sufficiently sized for the 10-year flow. The high water surface elevation within Gardens Channel reduces the ability of tributary storm drains to convey flow into the Channel and in some cases, causes surcharging of storm drains. Upsizing the channel, therefore, is a high priority for improvement within the Gardens Watershed.

Subarea 1

Upsizing the catch basins at the intersection of W Civic Center Drive and English Street decreases the flooding that drains south along English Street. Additionally, upsizing the mainline storm drain along English Street that ties into the system on W 5th street further reduces the flooding.

Subarea 4

The ponding that occurs along S Center Street is improved by upsizing the undersized catch basin that connects to the storm drain system along W Myrtle Street.

Subarea 14

Upsizing the system along Center Street and Edinger Avenue south of Wilshire Avenue prevents overflow from continuing south and flooding the intersection of Raitt Street and Occidental Street. Additionally, the catch basins within the intersection of Edinger Avenue and Center Street are undersized for the 10-year flow rate. Increasing the size of these catch basins also reduces the amount of overflow.

Subarea 20

The catch basin within Raitt Street and Glenwood Place is sufficiently sized to capture flow from the north. The storm drain from this catch basin, however, is unable to convey this flow to Gardens Channel. Upsizing this storm drain prevents overflow from collecting in the neighborhood to the west.

Subarea 21 & 22

Flooding issues along Rene Drive on the east side of Gardens Channel can be improved by upsizing the catch basin and lateral at St Gertrude Place and Rene Drive.

Subarea 29

Also upsizing the catch basin and lateral at the intersection of Adams Street and Rene Drive alleviates flooding.

Subarea 30

The three catch basins and laterals located the southern end of the cul-de-sacs of Rene Drive, Rita Way, and Pacific Avenue just north of Segerstrom Avenue are undersized for 10-year scenario. These catch basins cause ponding within their respective cul-de-sacs, but also along Segerstrom Avenue and to the south along Carriage Drive. Increasing the sizes of these facilities prevents the flooding.

Subarea 39

Upsizing the nine catch basins in the neighborhood bounded on the north by Alton Avenue, on the west by Bristol Street, on the south by MacArthur Boulevard, and on the east by Lowell Street improves ponding in this neighborhood and along MacArthur Boulevard.

5.2.1 Drainage Improvements

5.2.1.1 Gardens Catch Basins

Table 5-3 lists which catch basins are recommended for improvement. Details on existing and proposed catch basin sizes can be found in Appendix F.

Table 5-3: Gardens Proposed Upsized Catch Basins

Sub Area 1
CB-9, CB-10
Sub Area 2
CB-162
Sub Area 14
CB-51, CB-52, CB-53
Sub Area 16
CB-59, CB-60, CB-61
Sub Area 21
CB-211
Sub Area 22
CB-213
Sub Area 29
CB-282, CB-283
Sub Area 30
CB-249, CB-248, CB-245
Sub Area 39
CB-92, CB-93, CB-94, CB-95, CB-96, CB-97, CB-98, CB-99, CB-100, CB-105
Sub Area 40
CB-133, CB-134, CB-132, CB-135, CB-143, CB-144, CB-145, CB-151, CB-147, CB-148, CB-149, CB-150

5.2.1.2 Gardens Proposed SD Improvements

Table 5-4 lists the recommended storm drain improvements. Details on cost estimates can be found in Appendix C.

Table 5-4: Gardens Proposed Storm Drains

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
English St	SAGC_103-109_A_EX	30	DBL 24	31
English St	SAGC_109-115_1_EX	5.4 x 3.3 ARCH	DBL 4' x 3' RCB	18
English St	SAGC_109-115_2_EX	5.4 x 3.3 ARCH	DBL 4' x 3' RCB	65

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
English St	SAGC_109-115_3_EX	5.4 x 3.3 ARCH	DBL 4' x 3' RCB	417
English St	SAGC_109-115_4_EX	5.4 x 3.3 ARCH	DBL 4' x 3' RCB	518
Sub Area 14				
S Center St	SAGC_203-204_3_EX	36	42	47
S Center St	SAGC_203-204_E_EX	18	24	55
S Center St	SAGC_203-204_4_EX	36	48	34
S Center St	SAGC_203-204_5_EX	36	48	207
S Center St	SAGC_203-204_6_EX	36	54	122
S Center St	SAGC_204-209_1_EX	36	54	461
S Center St	SAGC_204-209_A_EX	18	24	28
S Center St	SAGC_204-209_2_EX	36	54	48
S Center St	SAGC_204-209_3_EX	36	54	16
W Edinger Ave	SAGC_209-210_1_EX	54	72	100
W Edinger Ave	SAGC_209-210_2_EX	54	72	713
W Edinger Ave	SAGC_209-210_3_EX	54	72	470
Sub Area 18				
Santa Ana Gardens Channel	SAGC_222-227_4_EX	54	66	38
Santa Ana Gardens Channel	SAGC_210-235_3_EX/Link625	4' x 9' TRAP (1.5 :1 SLOPE)	14' x 9' REC	416
Santa Ana Gardens Channel	SAGC_235-245_2_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	103
Santa Ana Gardens Channel	SAGC_235-245_3_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	434
Santa Ana Gardens Channel	SAGC_245-241_1_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	398
Sub Area 19				
Santa Ana Gardens Channel	SAGC_241-416_1_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	73
Santa Ana Gardens Channel	SAGC_241-416_2_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	150
Sub Area 20				
Santa Ana Gardens Channel	SAGC_416-248.5_1_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	125
Santa Ana Gardens Channel	SAGC_416-248.5_2_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	341
Santa Ana Gardens Channel	SAGC_416-248.5_3_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	19
Glenwood Pl	SAGC_248-248.5_1_EX	24	2-36	1192
Glenwood Pl	SAGC_248-248.5_2_EX	33	48	132
Santa Ana Gardens Channel	SAGC_248.5-265_1_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	783
Sub Area 21				
W St Gertrude Pl	SAGC_263-264_A_EX	30	36	77
W St Gertrude Pl	SAGC_264-265_1_EX	30	36	118
Sub Area 23				
S Forest Ave	SAGC_259-260_1_EX	36	48	130

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Santa Ana Gardens Channel	SAGC_260-271_1_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	30
Sub Area 24				
Santa Ana Gardens Channel	SAGC_265-254_1_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	202
Santa Ana Gardens Channel	SAGC_254-260_1_EX	4' x 9' TRAP (1.5 :1 SLOPE)	18' x 9' REC	692
Sub Area 29				
Santa Ana Gardens Channel	SAGC_271-279_2_EX	4' x 14' TRAP (1.5 :1 SLOPE)	18' x 14' REC	288
Santa Ana Gardens Channel	SAGC_271-279_3_EX	4' x 14.5' TRAP (1.5 :1 SLOPE)	18' x 14.5' REC	700
Santa Ana Gardens Channel	SAGC_271-279_4_EX	4' x 14.5' TRAP (1.5 :1 SLOPE)	18' x 14.5' REC	292
Santa Ana Gardens Channel	SAGC_279-315_1_EX	4' x 14.5' TRAP (1.5 :1 SLOPE)	18' x 14.5' REC	158
Adams St	SAGC_314-315_A_EX	21	30	97
Adams St	SAGC_314-315_1_EX	30	42	37
Adams St	Link616/Link633	36	42	104
Santa Ana Gardens Channel	SAGC_279-315_3_EX	4' x 10' TRAP (1.5 :1 SLOPE)	22' x 10' REC	45
Santa Ana Gardens Channel	SAGC_315-283_1_EX	4' x 10' TRAP (1.5 :1 SLOPE)	22' x 10' REC	140
Santa Ana Gardens Channel	SAGC_315-283_2_EX	4' x 10' TRAP (1.5 :1 SLOPE)	22' x 10' REC	318
Sub Area 30				
Santa Ana Gardens Channel	SAGC_283-287_1_EX	4' x 10' TRAP (1.5 :1 SLOPE)	22' x 10' REC	82
Santa Ana Gardens Channel	SAGC_283-287_2_EX	4' x 10' TRAP (1.5 :1 SLOPE)	22' x 10' REC	300
Santa Ana Gardens Channel	SAGC_283-287_3_EX	14' x 9' TRAP (1.5 :1 SLOPE)	22' x 9' REC	183
Santa Ana Gardens Channel	SAGC_287-304_1_EX	14' x 9' TRAP (1.5 :1 SLOPE)	22' x 9' REC	517
Segerstrom Ave	SAGC_323-324_A_EX	36	36	165~
S Rita Way	SAGC_320-325_C_EX	18	18	27~
S Pacific Ave	SAGC_319-320_H_EX	18	18	30~
Sub Area 31				
Santa Ana Gardens Channel	SAGC_287-304_3_EX	14' x 9' TRAP (1.5 :1 SLOPE)	40' x 9' REC	21
Santa Ana Gardens Channel	SAGC_287-304_4_EX	14' x 9' TRAP (1.5 :1 SLOPE)	40' x 9' REC	11
Santa Ana Gardens Channel	SAGC_304-329_1_EX	14' x 9' TRAP (1.5 :1 SLOPE)	40' x 9' REC	20
Santa Ana Gardens Channel	SAGC_304-329_2_EX	14' x 9' TRAP (1.5 :1 SLOPE)	40' x 9' REC	190
Santa Ana Gardens Channel	SAGC_329-309_1_EX	14' x 9' TRAP (1.5 :1 SLOPE)	40' x 9' REC	192

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Santa Ana Gardens Channel	SAGC_329-309_2_EX	14' x 9.5' TRAP (1.5 :1 SLOPE)	40' x 9' REC	140
Sub Area 32				
Santa Ana Gardens Channel	SAGC_309-333_1_EX	14' x 9.5' TRAP (1.5 :1 SLOPE)	40' x 9' REC	160
Santa Ana Gardens Channel	SAGC_309-333_2_EX	14' x 11' TRAP (1.5 :1 SLOPE)	40' x 10.5' REC	139
Santa Ana Gardens Channel	SAGC_333-338_1_EX	14' x 12.5' TRAP (1.5 :1 SLOPE)	40' x 11' REC	61
Sub Area 33				
Santa Ana Gardens Channel	SAGC_333-338_2_EX	14' x 12.5' TRAP (1.5 :1 SLOPE)	40' x 11' REC	450
Santa Ana Gardens Channel	SAGC_338-347_1_EX	14' x 12.5' TRAP (1.5 :1 SLOPE)	40' x 11' REC	95
Sub Area 40				
Bay Crest St	SAGC_392-393_B_EX	18	24	7
S Sea Breeze	SAGC_392-393_2_EX	18	36	534
Wakeham Pl	SAGC_392-393_3_EX	18	36	27
Wakeham Pl	SAGC_392-393_C_EX	18	24	20
Wakeham Pl	SAGC_393-397_1_EX	18	42	375
S Bear St	SAGC_393-397_2_EX	18	42	331
S Plaza Dr	SAGC_396-397_B_EX	18	18	77~
S Plaza Dr	SAGC_396-397_A_EX	18	18	86~
S Plaza Dr	SAGC_396-397_1_EX	36	42	209
S Plaza Dr	SAGC_396-397_D_EX	18	18	56~
S Plaza Dr	SAGC_396-397_2_EX	36	54	385
S Plaza Dr	SAGC_396-397_F_EX	18	18	56~
S Plaza Dr	SAGC_396-397_3_EX	39	60	140
S Plaza Dr	SAGC_396-397_H_EX	18	18	56~
S Plaza Dr	SAGC_396-397_4_EX	54	72	282
Sunflower Ave	SAGC_397-398_1_EX	54	72	1250
Sunflower Ave	SAGC_397-398_2_EX	54	72	110
Sunflower Ave	SAGC_397-398_3_EX	60	72	33
Sunflower Ave	SAGC_397-398_5_EX	60	72	166
Sunflower Ave	SAGC_397-398_6_EX	60	72	330

*New pipe
~Slope change

5.3 Cost Estimates

Table 5-5 shows the proposed storm drain cost estimate summary. For detailed cost estimates see Appendix C.

Table 5-5: Gardens Proposed Storm Drain Cost Estimate

Gardens Proposed Storm Drain Cost Estimate	
Sub Areas	**Total Project Cost**
1 - 3	$1,048,000

4 - 20	$24,010,000
21 & 41	$135,000
22 – 30	$29,208,000
31 - 40	$18,954,000
Total	**$73,355,000**

6 Greenville-Banning Watershed

The Greenville-Banning watershed lies entirely within the City of Santa Ana and is approximately 3.6 sq. miles (2,300 acres). The Greenville-Banning Watershed is bounded by Spurgeon Intermediate School to the north, the Santa Ana River to the west, MacArthur Boulevard and Sunflower Avenue to the south, and Sullivan Street, Santa Ana Valley High School, South Greenville Street, and South Raitt Street to the east. The watershed consists of two (2) main storm drain drainage systems; (1) Greenville West System and (2) Greenville-Banning Channel. Both systems are tributary to Santa Ana River.

The largest storm drain system is the Greenville-Banning Channel (OCFCD Facility No. D03). Greenville-Banning Channel is a flood control facility owned and maintained by the Orange County Flood Control District (OCFCD). Historically, the watershed drained westerly into the Santa Ana River. Stabilization efforts and sediment laden flows on the Santa Ana River caused the invert elevation to equalize above the adjacent land. The Talbert Drainage District constructed the "Talbert Drainage Ditch" to help alleviate the drainage problems in the area, but the ditch was too small to effectively eliminate flooding issues. Greenville-Banning Channel was constructed in 1958-59 to replace the Talbert Drainage Ditch.

Greenville-Banning Channel, which is tributary to 93% of the total watershed, contains the Greenville-Banning Channel with a tributary area of approximately 2,170 acres. A series of storm drain systems collect flow and outlet to the Greenville-Banning Channel. The existing system ranges in size from 18-inches (laterals) to a 12' x 7.5' Reinforced Concrete Box (RCB). Runoff generally flows south with some areas flowing slightly west or east.

The Greenville West System (OCFCD Facility No. D03P01) has a tributary area of approximately 170 acres (~7% of total watershed) and ranges from 27-inches to 69-inches RCP. The Greenville West System is tributary to the Santa Ana Greenville-Banning Channel.

6.1 Existing Condition

The existing condition flood routing analyses were performed to identify existing street surface conveyance and storm drain capacities and to acquire a benchmark for the proposed analyses. The 10- and 100-year annual chance models were then calculated to develop a basis for the evaluation and development of potential drainage improvements.

In this study, the following updates were made to the SDMP Phase 1 hydrology delineation and/or storm drain geometry. This update/revision is to further define the drainage pattern. Figure 6-1 shows the Greeneville-Banning watershed subarea map.

Subarea 1

1. CB-167 was split in two separate catch basins based on Google Earth. The western lateral was a 24-in RCP based on as-builts and the other was assumed as 24-in RCP due to the lack of as-built or OC facility map information. The invert and length for the western lateral was taken from the as-built. For the other lateral, the slope was assumed to be 1% based on slope of the street. The hydrograph and inflow-capture (from CB-167) were split equally between the two inlets.
2. CB-165 represents two catch basin inlets based on Google Earth. A second catch basin inlet (CB-297) was added to the model and the hydrograph and inflow-capture (from CB-165) were split equally. The laterals were assumed to be 24-in and 0.4% slopes due to the lack of as-built or OC facility map data.
3. CB-166 consists of five catch basins combined with a width of 77-ft. The existing condition was updated to the new existing capture flow based on FlowMaster calculations.

Subarea 7

1. CB-29 (SAGB_212-216_D_EX) - Lowered downstream (to match node invert from as-builts) and upstream inverts but maintained slope to rectify top of bank being above node existing ground elevation based on topography. No as-built information was found for the lateral, therefore the slope was assumed to be 2% to be consistent with the SDMP Phase 1.
2. CB-30 (SAGB_212-216_C_EX) - Lowered downstream (to match node invert from as-builts) and upstream inverts but maintained slope to rectify top of bank being above node existing ground elevation based on topography. No as-built information was found for the lateral, therefore the slope was assumed to be 1.98% to be consistent with the SDMP Phase 1.
3. CB-33(SAGB_217-222_A_EX) – CB-33 represents two combined inlets. Therefore, the catch basin was split to be two catch basins (CB-33 and Node295). The lateral was changed from 5.5’ to two 3’ laterals based on FlowMaster calculations. The upstream invert was calculated based off the downstream invert and an assumed 0.2% slope based on the slope of the street.
4. CB-36 (SAGB_216-222_D_EX) - Lowered downstream (to match node invert from as-builts) and upstream inverts but maintained slope to rectify top of bank being above node existing ground elevation based on topography. No as-built information was found for the lateral, therefore the slope was assumed to be 2% to be consistent with the SDMP Phase 1.
5. CB-35 (SAGB_216-222_C_EX) - Lowered downstream (to match node invert from CB-36) and upstream inverts but maintained slope to rectify top of bank being above node existing ground elevation based on topography. No as-built information was found for the lateral, therefore the slope was assumed to be 2.01% to be consistent with the SDMP Phase 1.
6. MH-10 (SAGB_216-222_1_EX) – raised spill crest of MH-10 since the top of bank was above spill crest due to the topography.
7. CB-27 is 4 inlets combined with a width of 48-ft. According to SDMP Phase 1, was deficient, but based on FlowMaster the existing condition captures 100% of the flow. Therefore, the existing condition was updated to the new existing capture from FlowMaster.

Subarea 8

1. SAGB_244-252_1_EX was incorrectly modeled as an open TRAP (causes significant flooding) when in fact is a double 9’x8’ RCB based on the OC Facilities Map. This was updated in the existing models. In addition, the link length was set at over 2,000 ft long when it should be 120’. This was also updated.

Subarea 13

1. CB-97 was split into two catch basins (CB-96 and CB-97) therefore the inflows were split equally between the inlets.

Subarea 18

1. CB-122 was split into two catch basins and therefore the inflows were split equally between the inlets (CB-122 and 123).

Subarea 19

1. MH-717 (SAGB_321.6-322_2_EX) – Lowered downstream (to match node invert from as-builts) and upstream inverts but maintained slope to rectify top of bank being above node ground elevation. Since no as-built information was found, the slope was assumed to be 1% to be consistent with the SDMP Phase 1.

Greenville-Banning Channel Tailwater

- *Greenville Banning Channel System Tailwater:*

In the SDMP Phase 1, the tailwater at the most downstream end of the study used the as-built data hydraulic data table. However, it was noted that the storm event for the as-built was not included. In this study, a detailed 1D channel hydraulic analysis was performed using HEC-RAS and the existing topographic surface and channel As-Builts. The HEC-RAS modeled the Greenville-Banning Channel from West Centennial Road to just upstream of South Coast Drive. The HEC-RAS results can be found in Appendix E.

The following assumptions were made:

1. For the bridge crossing the Greenville Banning Channel between the intersections of South Coast Drive and Sunflower Ave, the culvert was assumed to be a double 9' x 8' RCB based on Google Earth.
2. All other culvert size information was taken from the Greenville Banning Channel as-builts.
3. Elevations were taken from the HEC RAS model and Google Earth.
4. Downstream WSE for 10-year was calculated to be 3.4-ft above invert and for 100-year, 8.19-ft above invert based on HEC RAS model of the Channel (at XS 983.9269).
5. The 10-year and 100-year peak flow was taken from the FEMA Flood Insurance Study (FIS) and were found to be 150 cfs, 300 cfs, and 850 cfs for the 10-year, 50-year, and 100-year storm event, respectively. The flow rate in the as-built was 488 cfs, however no storm event was provided.

Greenville West System Tailwater:

The tailwater for the Greenville West System was taken from as-built HF 02-33. This is consistent with the SDMP Phase 1, where the 25-year depth was used for the 10-year model. The 10-year depth is not provided on the as-built. For the 100-year model, the tail water was set to the soffit elevation.

6.1.1 Existing Condition Results

A description of the major flooding areas within the Greenville-Banning watershed shown in the 10-year and 100-year existing models are discussed below. Figure 6-2 and Figure 6-3 show the 10-year and 100-year existing condition maximum depth results. Figure6-4 and Figure 6-5 shows the 10-year and 100-year existing condition duration of inundation maps.

Subarea 1

The existing modeling revealed an undersized lateral and catch basin causes flooding at the corner of South Huron Drive and South Arapaho Drive. The flooding originates at the catch basin and flows north on Huron Dr and west on Arapaho Drive within the residential area.

There is also flooding at the intersections of Fairview Street with Willis Street, West 1st Street, and West 5th Street caused by the undersized storm drain mainline, laterals, and associated catch basins on Fairview Street. There is flooding in the 10-year and 100-year storm event on north Fairview Street from West 5th Street to West Borchard Avenue due to the undersized mainline storm drain system and some catch basins and associated laterals. The flooding flows south along Fairview Street and South Marine Street.

Excessive flooding occurs on Fairview Street beginning near McFadden Avenue and continuing South to Warner Avenue and is caused by the deficient storm drain system along Fairview Street as well as the Greenville-Banning Channel being undersized. This causes significant flooding in both the 10-year and

100-year storm event along the street. This area is considered a priority due to the proximity to several schools along Fairview Street as well as a fire station on Warner Avenue.

Deficient catch basins cause flooding on the intersection of West Elder Avenue and South Huron Drive.

Subarea 2

Flooding along West Centennial Road is caused by the deficient storm drain that runs east to outlet into the Greenville Banning Channel. Additionally, the catch basins and corresponding laterals are also under capacity.

Subarea 3

Deficient catch basins cause flooding along West Castor Street.

Subarea 7

Additional flooding on Warner Avenue is caused by undersized catch basins and associated laterals joining the storm drain main that runs west along Warner before outletting to the Greenville Banning Channel.

Subarea 8

The undersized storm drain line and associated catch basins along Segerstrom Avenue causes flooding at the intersection with Fairview Street. This flooding continues west on Segerstrom and south on Fairview Street. The flow also impacts the residential area east of Fairview Street. The storm drain picks up flow from Manly Avenue, heads south on Fairview and west on Segerstrom before outletting to the Greenville Banning Channel.

Subarea 13

Other deficient catch basins on Sunflower Avenue cause additional flooding between the Greenville Banning Channel and South Raitt Street. This area is considered a priority due to the proximity to the proximity to Segerstrom High School.

There is flooding at the intersection of Raitt Street and MacArthur Boulevard caused by deficient catch basins.

Subarea 15

Flooding caused by undersized catch basins occurs on MacArthur and flows south down Susan Street to Sunflower Avenue.

6.1.1.1 Greenville-Banning Model Validation

The Greenville model was validated by comparing the intersection of 5th St and Fairview St. Photos were taken at the intersection during the December 22, 2016 storm showing minor flooding (see Section 6.1.2). These matches both the 10-year and 100-year models, which show flooding in that intersection.

6.1.2 Street Deficiency

Of the nodes which remain flooded in the existing condition, some of these nodes result in street deficiencies while the magnitude of flooding in other nodes do not result in street deficiencies. Streets are defined as being deficient if the max depth at a node/street is greater than the max allowable design protection. The 2D flooding inundation extent was used in conjunction with the 1D hydraulics to determine the street deficiency.

By comparing the magnitude of the maximum depth at each node and the 2D overland flooding which remains flooded in the existing condition with the max allowable depth according to each typical street section, streets are deficient at the following node locations shown on Table 6-1. There are no deficient street in the 10-year event.

Table 6-1: Greenville-Banning Street Deficiencies Per Max Allowable Flow (100-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
CB-166	Fairview Street	@ 1st Street	Arterial (100')	3.452	0.83
CB-27	Warner Ave	@ Diamond Street	Arterial (100')	2.316	0.83
MH-123	Fairview Street	S of 1st Street	Arterial (100')	2.003	0.83
CB-296	Fairview Street	@ Willits Street	Arterial (100')	1.237	0.83

6.1.3 Known Flooding Area and Winter 2017 Storms

City of Santa Ana has known flooding locations within the Greenville-Banning watershed. Some of these locations experienced significant flooding during the 2017 winter season. The flooding locations were observed and documented by the city maintenance crew. The flooding locations within the Greenville-Banning watershed include:

S. Fairview St. and W. 1st St.

On January 12, 2017, there was extremely heavy flooding on S. Fairview St. and W. 1st St. Several storm drains were clogged on S. Fairview due to a vehicle's front bumper blocking the storm drain inlet. The bumper was removed allowing for the flow to enter the storm drain.

Fairview St. and 1st St.

On January 12, 2017, the City responded to more complaints of heavy flooding on the intersections of Fairview St. and 1st St. Storm drains at the intersections were completely flooded due to heavy rains. The storm drains were unable to keep up with the inflow from the storm. No blockage was observed at site.

Fairview St. and 5th St.

Minor flooding was observed on December 22, 2016 and photographed at Fairview and 5th St.

Fairview St. and 5th St. – December 22, 2016 Storm

S. Fairview St. (between 1st St. and McFadden Ave.)

This location has been previously known by the city to be known to flood based on the SDMP Phase 1 Study.

Sullivan St. and 1st St.

This location has been previously known by the city to be known to flood based on the SDMP Phase 1 Study.

Fairview St. and Willis St.

On, January 12, 2017 heavy flooding was witnessed on the intersection of Fairview St. and Willis St. No debris or other obstruction was observed. Flooding was caused due to the heavy rainfall and the storm drains not able capture the incoming flow.

Raitt St. and MacArthur Blvd

On January 12, 2017, Inspectors observed that on Raitt St. and MacArthur Blvd the number 3 lane was flooded. Overflow of water was coming from Griset Park. There were no blockages of catch basins observed.

6.2 Proposed Condition

A description of the proposed improvement areas within the Greenville-Banning watershed are discussed below. For a compiled list of proposed improvements, see Table 6-2 and Table 6-3. Figure 6-6 and Figure 6-7 show the 10-year and 100-year proposed condition maximum depth results. Figure 6-8 and Figure 6-9 show the 10-year and 100-year proposed condition duration of inundation maps. Figure 6-10 and Figure 6-11 show the 10-year and 100-year difference (existing vs proposed) depth maps. Figure 6-12 through Figure 6-16 show the proposed facilities.

Subarea 13

Upsizing catch basins at the intersection of Raitt Street and MacArthur Boulevard reduces the flooding caused by the undersized catch basins.

Subarea 1

Flooding at the corner of South Huron Drive and South Arapaho Drive is reduced significantly by upsizing the catch basin and associated lateral at that intersection.

The flooding along Fairview Street can be substantially reduced by upsizing the mainline storm drain system. In addition, upsizing the catch basins along Fairview Street and some associated laterals will alleviate the flooding. These improvements will also remove flooding at the corner of South Huron Drive and South Arapaho Drive. The significant flooding on Fairview Street beginning near McFadden Avenue and continuing South to Warner Avenue is substantially reduced by upsizing the Orange County Flood Control Facility Greenville Banning Channel from McFadden Avenue to west of Borchard Avenue.

Flooding on the intersection of West Elder Avenue and South Huron Drive can be reduced by upsizing the catch basins and associated laterals.

Subarea 2

The flooding on West Centennial Road can be reduced by upsizing the catch basins and associated laterals as well as improving the mainline storm drain system.

Subarea 3

Flooding along West Castor Street can be improved by upsizing catch basins and associated laterals.

Subarea 7

Upsizing the catch basins and laterals at the intersection of Everglade Street and Warner Avenue will reduce the flooding along Warner Avenue.

Subarea 8

The flooding on Segerstrom Avenue near Fairview Street can be dramatically reduced by upsizing a catch basin and associated lateral as well as upsizing the mainline storm drain.

Subarea 15

Flooding on MacArthur Boulevard is greatly reduced by upsizing the catch basins along the storm drain system that begins east of Harbor Boulevard near the railroad crossing and continues along MacArthur before outletting to the Greenville Banning Channel.

Subarea 16

The flooding on Susan Street is caused by two systems. Upsizing the catch basins at the intersection of Susan Street and Alpine Street will reduce the flooding that occurs at that intersection and flows south to Sunflower Avenue. Additional flooding at the intersection of Sunflower and Susan can be remedied by upsizing the catch basins at that intersection.

6.2.1 Drainage Improvements

6.2.1.1 Greenville Banning Catch Basins

Table 6-2 lists which catch basins are recommended for improvement. Details on existing and proposed catch basin sizes can be found in Appendix F.

Table 6-2: Greenville Banning Proposed Upsized Catch Basins

Sub Area 1
CB-165, CB-297, CB-167, CB-296*, CB-168, CB-169, CB-307*, CB-308*, CB-172, CB-177, CB-175, CB-176
Sub Area 2
CB-158
Sub Area 3
CB-156
Sub Area 4
CB-18
Sub Area 5
CB-4, CB-10, CB-23
Sub Area 6
CB-13, CB-15, CB-25
Sub Area 7
CB-298, CB-299, CB-42, CB-33
Sub Area 8
CB-43, CB-46
Sub Area 9
CB-50, CB-52
Sub Area 10
CB-178, CB-179
Sub Area 11
CB-180
Sub Area 12
CB-56
Sub Area 13
CB-119, CB-120, CB-106, CB-96, CB-97
Sub Area 14
CB-82
Sub Area 15
CB-76, CB-80
Sub Area 16
CB-88, CB-84
18
CB-122
Sub Area 19
CB-148

*New catch basin

6.2.1.2 Greenville Banning Proposed SD Improvements

Table 6-3 lists the recommended storm drain improvements. Details on cost estimates can be found in Appendix C.

Table 6-3: Greenville Banning Proposed Storm Drains

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
Willits St	Link386	24	48	38
Fairview St	SAGB_114-118_1_EX	54	60	329
Fairview St	SAGB_114-118_2_EX	54	60	999
Fairview St	SAGB_118-122_1_EX	54	60	304
Fairview St	SAGB_118-122_2_EX	54	60	337
Fairview St	SAGB_118-122_3_EX	54	66	767
Fairview St	SAGB_118-122_4_EX	54	72	472
Fairview St	SAGB_119-122_A_EX	18	42	38
Fairview St	SAGB_122-133_1_EX	54	72	419
Fairview St	SAGB_122-133_2_EX	54	72	699
Fairview St	SAGB_122-133_3_EX	60	72	651
Fairview St	SAGB_122-133_4_EX	60	72	236
Fairview St	SAGB_122-133_5_EX	60	72	142
Fairview St	SAGB_122-133_6_EX	60	72	15
Fairview St	SAGB_123-133_A_EX	30	48	244
Greenville Banning Channel	SAGB_133-139_1_EX	4.5’ x 3.75’ TRAP (1:1)	12’ x 3.75’ REC	219
Greenville Banning Channel	SAGB_139-143_1_EX	4.5’ x 3.75’ TRAP (1:1)	12’ x 3.75’ REC	742
Greenville Banning Channel	SAGB_143-149_2_EX	4.5’ x 3.95’ TRAP (1:1)	12’ x 3.95’ REC	526
Greenville Banning Channel	SAGB_149-154_1_EX	4.5’ x 3.95’ TRAP (1:1)	12’ x 3.95’ REC	262
Greenville Banning Channel	SAGB_149-154_2_EX	4.5’ x 3.95’ TRAP (1:1)	12’ x 3.95’ REC	84
Greenville Banning Channel	SAGB_154-159_1_EX1	4.5’ x 4.46’ TRAP (1:1)	12’ x 4.46’ REC	89
Fairview St	Link396*	-	24	103
Fairview St	Link397*	-	24	105
Sub Area 2				
W Centennial Rd	SAGB_176-179_A_EX	30	36	17
W Centennial Rd	SAGB_176-179_B_EX	24	36	4
W Centennial Rd	SAGB_179-180_1_EX	30	60	83
W Centennial Rd	SAGB_179-180_2_EX	42	60	184
W Centennial Rd	SAGB_179-180_3_EX	42	60	303
W Centennial Rd	SAGB_179-180_4_EX	42	60	278
W Centennial Rd	SAGB_179-180_5_EX	42	60	185
Sub Area 3				
Fairview St	SAGB_181-186_A_EX	42	60	87
W Castor St	SAGB_181-186_B_EX	18	60	36
Fairview St	SAGB_181-186_C_EX	24	60	118
Fairview St	SAGB_186-187_1_EX	42	60	37

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 6				
W Pendleton Ave	SAGB_208-227_A_EX	21	39	84
Sub Area 7				
Fairview St	Link388*	-	48	76
Fairview St	Link389*	-	48	45
S Everglade St	SAGB_222-226_B_EX	12	24	25
S Everglade St	SAGB_222-226_C_EX	18	24	38
Sub Area 8				
Fairview St	SAGB_231-235_2_EX	42	48	575
W Segerstrom Ave	SAGB_232-235_A_EX	51	60	66
W Segerstrom Ave	SAGB_235-244_1_EX	51	60	95
W Segerstrom Ave	SAGB_235-244_2_EX	51	60	577
Sub Area 12				
Fairview St	SAGB_267-270_A_EX	24	36	79
Fairview St	SAGB_267-270_B_EX	24	36	9
Fairview St	SAGB_269-270_1_EX	24	36	199
Sub Area 13				
S Raitt St	SAGB_275-278_A_EX	21	30	28
Sub Area 14				
W MacArthur Blvd	SAGB_291-294_B_EX	24	36	66
Sub Area 18				
S Croddy Way	SAGB_327-330_A_EX	27	48	33
W Segerstrom Ave	SAGB_330-331_1_EX	48	66	164
W Segerstrom Ave	SAGB_330-331_2_EX	54	66	142
W Segerstrom Ave	SAGB_330-331_3_EX	57	66	726
North of W Garry Ave	SAGB_330-331_4_EX	60	66	687
W Garry Ave	SAGB_330-331_5_EX	60	66	18

*New Link

6.3 Cost Estimates

Cost estimates have been completed for all proposed improvements in the 10-year condition. The grouping of all sub areas remains consistent with the grouping within the proposed facilities exhibits.

Table 6-4 shows the proposed storm drain cost estimate summary. For detailed cost estimates see Appendix C.

Table 6-4: Greenville Banning Proposed Storm Drain Cost Estimate

Greenville Banning Proposed Storm Drain Cost Estimate	
Sub Areas	**Total Project Cost**
1	$8,733,000
2 - 7	$1,351,000
8 - 10, 18, & 20	$3,325,000
11 - 17 & 19	$266,000
Total	**$13,675,000**

7 Lane-Barranca Watershed

The Lane-Barranca Watershed lies entirely within the City of Santa Ana. Lane Watershed is approximately 2.6 sq. miles (1,666 acres). The watershed is generally bounded by the AT&SF Railroad on the north, the Southern Pacific Railroad and Main Street on the West, the I-405 Freeway and Campus Drive on the South, and the SR-55 Freeway and Von Karman Avenue on the East. Lane watershed is fully developed consisting mainly of commercial and industrial land use. The Lane-Barranca watershed drains to Lane Channel (OCFCD Facility No. F08), a tributary to San Diego Creek.

At its downstream location, Lane Channel is an earthen trapezoidal channel from its confluence with San Diego Creek immediately upstream of the I-405 Freeway and continues upstream and parallel to the I-405 for roughly 6,800 ft until it reaches the MacArthur Boulevard off-ramp. At this location, the channel transitions into a triple reinforced concrete box (RCB) and turns northerly to run along MacArthur Boulevard until it crosses Main Street, approximately 600 ft north. After crossing Main Street, it transitions back from a triple RCB to a concrete-lined rectangular channel and continues north along MacArthur Boulevard. The channel continues until it reaches the SR-55 Freeway, and crosses underneath as a double RCB. This facility then transitions to an earthen trapezoidal channel that runs parallel to the westerly side of SR-55.

There are four main storm drain systems within the Lane-Barranca watershed. The western most system drains the area west of Halladay Street and joins Lane Channel via a culvert within MacArthur Boulevard southeast of the intersection of MacArthur Boulevard and the 55 Freeway. The line within Tech Center Drive drains the area east of Halladay Street and west of Grand Avenue before joining Lane Channel near the southern terminus of Tech Center Drive. The large area west of Ritchey Street and east of Grand Avenue is drained by a system extending north up to the UPRR train tracks. This system connects to Lane Channel at the south end of Grand Avenue. The easternmost system drains the area east of Ritchey Street and joins Lane Channel at the southern terminus of Auto Mall Drive.

The runoff generally flows to the southwest via existing street gutters and storm drain network towards Lane Channel.

7.1 Existing Condition

The existing condition flood routing analyses were performed to identify existing street surface conveyance and storm drain capacities and to acquire a benchmark for the proposed analyses. The 10- and 100-year annual chance models were then calculated to develop a basis for the evaluation and development of potential drainage improvements.

In this study the following updates were made to the SDMP Phase 1 hydrology delineation and/or storm drain geometry. This update/revision is to further define the drainage pattern. Figure 7-1 shows the Lane-Barranca watershed subarea map.

Subarea 3

1. Lowered upstream invert elevation of SALB_143-144_A_EX, SALB_164-169_1_EX by 0.2-ft. These are links representing multiple laterals. When the sizes of the existing laterals were combined, these links (storm drains) were above the ground surface.

Subarea 4

1. CB-32 represents a sidewalk drain and not a catch basin. Deactivated this node and moved the discharges into CB-29.
2. Lowered upstream invert elevation of SALB_134-146_A_EX by 0.2-ft. This link (storm drain) was above the ground surface. This link represents multiple laterals. When the sizes of the existing laterals were combined, this link (storm drains) was above the ground surface.
3. Added storm drain system along Auto Mall Drive and east of Ritchey St. and North of 55. Revised hydrology in this area, which affected 10 and 100-year hydrographs in CB-34, CB-35, CB-36, CB-47.

Subarea 5

1. Added in 10-ft wide trapezoidal channel from S. Santa Fe St. toward railroad tracks as 1D channel based on as-builts.

Subarea 6

1. Added a missing catch basin on Lyon Street south of St. Andrew Place based on OC facility maps.

Subarea 9

1. Removed link (storm drain) from T-23 to MH-191 according to Orange County facility map. Revised hydrology for inflow into Node244, Node243, and CB-59.

Subarea 15

1. Lowered downstream invert (to match node invert from as-builts) and upstream inverts for SALB_320-329_A_EX but maintained slope to rectify top of bank being above node existing ground elevation based on topography.
2. Reduced size of SALB_330-331_A_EX to 5.0-ft from 7.5-ft. To accurately represent combined catch basin inlets, the laterals were combined based on capacity rather than diameter, which resulted in a smaller size.
3. Added fill areas for bridge representing SR-55 over Lane Channel as the existing topography shows as depression/hole.
4. The mainline flow was input as the hydrograph in CB-72. Revised this so that the hydrograph corresponded to the drainage area.
5. Added last sub area flow into MH-7.

Global

1. Removed backwater at Node 227 and modeled as a head boundary.
2. Added fill area for bridge over Lane Channel adjacent to Fitch and MacArthur intersection as the existing topography shows as depression/hole.
3. The tailwater for the Lane-Barranca Channel was taken from the SDMP Phase 1. The tailwater depths were calculated using a normal depth calculation and provided a depth of 6.86' in the 10-year and 7.83' in the 100-year.

7.1.1 Existing Condition Results

A description of the major flooding areas within the Lane-Barranca watershed shown in the 10-year and 100-year existing models are discussed below. Figure 7-2 and Figure7-3 show the 10-year and 100-year existing condition maximum depth results. Figure 7-4 and Figure 7-5 show the 10-year and 100-year existing condition duration of inundation maps.

Subarea 3

In the 10-year existing condition scenario, Kennedy Elementary School experiences moderate flooding along McFadden Avenue and to the south. This flow continues south and causes flooding in Borchard Avenue due to deficient catch basins and laterals along McFadden Avenue west of Grand Avenue. The flooding in Borchard Avenue is also caused by an undersized catch basin and main line within Grand Avenue north of Edinger Avenue. This system is unable to accommodate flows coming from approximately 60 acres to the north and east. The flooding at Edinger Avenue west of Grand Avenue is also due to the lack of capacity of this system.

Subarea 5

The storm drain main line within Warner Avenue between Standard Avenue and Grand Avenue is undersized and causes the catch basin at the intersection of Standard and Warner to flood. In addition to the flow surcharging out of the catch basin, there is also flow that drains toward the catch basin. This flow is unable to enter the catch basin due to the deficient catch basin, resulting in excessive ponding at this intersection which then flows south into the train track area.

Subarea 6

The flooding at the intersection of St. Andrew Place and Santa Fe Street is caused by two separate storm drain deficiencies. There is an undersized storm drain main line and catch basin located near the intersection of Grand Avenue and St. Andrew Place that results in excessive ponding. There is also an open trapezoidal channel south of St. Andrew Place that surcharges due to a backwater effect from the storm drain line located parallel to the railroad tracks to the west.

Subarea 10

The storm drain main line beginning at Evergreen Street south of Flora Street experiences a backwater effect from Lane Channel, making it difficult for this line to drain the large tributary area. This results in extensive flooding along Evergreen Street, Tech Center Drive, and Dyer Road. This is compounded by the undersized storm drain line along Grand Avenue north of Dyer Road and south of Brookhollow Drive. This storm drain also experiences a backwater effect from Lane Channel, reducing the ability of the catch basin near Brookhollow Drive and Grand Avenue to function at its full capacity.

Subarea 14

The First American Financial Corporation’s complex south of Columbine Avenue experiences over one foot of flooding in the 10-year scenario due to two deficient storm drain lines in addition to the backwater effect from Lane Channel on the storm drains.

Subarea 15

Some minor ponding along Columbine Avenue east of Main Street is caused by a slightly undersized catch basin and lateral in Columbine Avenue. This catch basin also causes ponding along Main Street south of Macarthur Boulevard. In addition, a catch basin at the intersection of Alton Avenue and Maple Street is undersized, sending flow south along Maple Street toward Columbine Avenue.

7.1.1.1 Lane-Barranca Model Validation

The Lane-Barranca model was validated by comparing flooding at the intersection of Warner Ave and Standard Ave. Photos were taken at the intersection during the January 5, 2017 storm showing approximately 0.5 feet of flooding (see Section 7.1.2). This storm, according to some estimates was between a 10- and 25-year storm event. Both the 10-year and 100-year XPSWMM model show flooding of 0.5-1.0 feet in that intersection.

7.1.2 Street Deficiency

Of the nodes which remain flooded in the existing condition, some of these nodes result in street deficiencies while the magnitude of flooding in other nodes do not result in street deficiencies. Streets are defined as being deficient if the max depth at a node/street is greater than the max allowable design protection. The 2D flooding inundation extent was used in conjunction with the 1D hydraulics to determine the street deficiency.

By comparing the magnitude of the maximum depth at each node and the 2D overland flooding which remains flooded in the existing condition with the max allowable depth according to each typical street section, streets are deficient at the following node locations shown on Table 7-1 and Table 7-2.

Table 7-1: Lane-Barranca Street Deficiencies Per Max Allowable Flow (100-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
CB-50	Brookhollow Dr	E of Grand Ave	Local	2.648	0.71
CB-18	Columbine Ave	@ Halladay Street	Local	1.443	0.71
CB-71	Columbine Ave	E of MacArthur Pl	Local	0.923	0.71
CB-73	E St Andrew Place	@ Santa Fe St	Local	1.123	0.71
CB-43	E Warner Ave	@ Railroad	Arterial (120')	2.778	0.85
MH-99	E Warner Ave	@ Railroad	Arterial (120')	1.867	0.85
MH-263	S. Grand Ave	@ SR-55	Arterial (120')	3.865	0.85
MH-96	S. Grand Ave	@ SR-55	Arterial (120')	3.254	0.85
MH-209	S. Grand Ave	@ Brookhollow Dr	Arterial (120')	3.201	0.85

Table 7-2: Lane-Barranca Street Deficiencies Per Max Allowable Flow (10-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
MH-263	S. Grand Ave	@ SR-55	Arterial (120')	2.783	0.73
CB-50	Brookhollow Dr	E of Grand Ave	Local	2.661	0.5
MH-96	S. Grand Ave	@ SR-55	Arterial (120')	2.088	0.73
MH-209	S. Grand Ave	@ Brookhollow Dr	Arterial (120')	1.813	0.73
CB-51	S. Grand Ave	@ SR-55	Arterial (120')	0.887	0.73
CB-73	E St Andrew Place	@ Santa Fe St	Local	0.675	0.5

7.1.3 Known Flooding Area and Winter 2017 Storms

Alton Ave. (between Main St. and Oak St.)

This location has been previously indicated by the city to be known to flood based on the SDMP Phase 1 Study.

Alton Ave. and Standard Ave.

This location has been previously indicated by the city to be known to flood based on the SDMP Phase 1 Study.

Warner Ave. and Standard Ave.

On January 5th, 2017 flooding was observed at the intersection of Warner Ave and Standard Ave.

Warner Ave and Standard Ave – January 05, 2016 Storm

7.2 Proposed Condition

A description of the proposed improvement areas within the Lane-Barranca watershed are discussed below. For a compiled list of proposed improvements, see Table 7-3 and Table 7-4. Figure 7-6 and Figure 7-7 show the 10-year and 100-year proposed condition maximum depth results. Figure 7-8 and Figure 7-9 show the 10-year and 100-year proposed condition duration of inundation maps. Figure 7-10 and Figure 7-11 show the 10-year and 100-year difference (existing vs proposed) depth maps. Figure 7-12 through Figure 7-15 show the proposed facilities.

Subarea 3

The flooding within Kennedy Elementary School can be reduced substantially by adding additional catch basins and upsizing their associated laterals along McFadden Avenue (west of Grand). The recommended improvements also benefit the ponding within Borchard Avenue, as overflow from the existing catch basins within McFadden travels southward and onto Borchard Ave.

The existing deficient system within Grand Avenue south of McFadden contributes to the flooding within Borchard Ave. and Edinger Avenue (west of Grand Avenue). The flooding in this area can be reduced by adding three catch basins and upsizing the most portion of the system within Grand Avenue. This proposed system would improve flooding within Edinger Avenue west of Grand Avenue as well.

Subarea 5

The industrial area west of Grand Avenue including Pomona Street, Santa Fe Street, and St. Andrew Place and Grand Avenue south of Pomona Street experience flooding due to an undersized main line within Grand Avenue. Upsizing a portion of this system allows most of the street runoff to be captured and conveyed downstream within the storm drain system.

Subarea 6

Upsizing and extending the storm drain system along St. Andrew Place west of Ritchey Street serves two purposes. It reduces the amount of flooding along St. Andrew Place and captures flows along Ritchey Street that would otherwise flow toward Wright Street and contribute to flooding within Warner Avenue.

Subarea 7

Brookhollow Drive's existing ponding can be improved by upsizing the lateral and main line storm drain from Brookhollow Drive down to the headworks of Lane Channel, along to the SR-55 Freeway.

Subarea 10

Improvements to the main line within Tech Center Drive result in reductions in flooding along Tech Center Drive and Evergreen Street. These improvements include upsizing the main line and upsizing catch basins that connect to this main line.

The train tracks south of Warner Avenue along Beeson Lane are flooded by an undersized main line along Beeson south of St. Gertrude Place and along Warner east of St. Gertrude Place. Upsizing main line to an 8'Hx8'W RCB and adding four additional 21' catch basins reduces the volume of overland flow along the tracks.

Subarea 14

The First American Financial Corporation campus located southeast of Columbine Avenue and First American Way is flooded due to two deficient storm drain lines that drain into Lane Channel. Upsizing the lines and adding a 21' and a 14' catch basin along First American Way significantly improves the surface ponding in this area.

Subarea 15

Near the southwest area of Lane watershed, street flooding along Main Street and Columbine Avenue is caused by two undersized laterals and catch basins. Increasing the size of a lateral within Columbine Avenue east of Main St. improves the surface street flooding. Adding a 28' catch basin and upsizing the associated lateral at the intersection of Maple Street and Alton Avenue further reduces ponding along Alton Avenue.

7.2.1 Drainage Improvements

7.2.1.1 Lane-Barranca Catch Basins

Table 7-3 lists which catch basins are recommended for improvement. Details on existing and proposed catch basin sizes can be found in Appendix F.

Table 7-3: Lane Barranca Proposed Upsized Catch Basins

Sub Area 1
CB-30
Sub Area 2
CB-24, CB-75, CB-76

Sub Area 3
CB-74, CB-207, CB-23
Sub Area 4
CB-36
Sub Area 5
CB-39, CB-40, CB-41, CB-73, CB-43
Sub Area 6
CB-26, Node240*, Node238*
Sub Area 7
CB-50
Sub Area 10
Node241
Sub Area 11
CB-63
Sub Area 12
CB-64
Sub Area 14
CB-12
Sub Area 15
CB-61, CB-237, CB-71, CB-72

7.2.1.2 Lane-Barranca Proposed SD Improvements

Table 7-4 lists the recommended storm drain improvements. Details on cost estimates can be found in Appendix C.

Table 7-4: Lane Barranca Proposed Storm Drains

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
E McFadden Ave	SALB_114-115_A_EX	24	48	250
E McFadden Ave	SALB_114-115_B_EX	24	48	50
Sub Area 2				
E McFadden Ave	SALB_110.5-114_C_EX	24	36	380
E McFadden Ave	SALB_110.5-114_D_EX	24	36	32
Sub Area 3				
S Grand Ave	SALB_118-120_A_EX	24	36	92
S Grand Ave	SALB_118-120_1_EX	36	42	351
S Grand Ave	SALB_118-120_2_EX	36	42	252
E Edinger Ave	SALB_120-121_A_EX	36	42	97
E Edinger Ave	SALB_120-121_B_EX	36	42	8
E Edinger Ave	SALB_120-121_C_EX	36	42	58

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 5				
S Grand Ave	SALB_164-169_1_EX	30	42	169
S Grand Ave	SALB_164-169_2_EX	30	42	124
S Grand Ave	SALB_164-169_3_EX	30	42	720
West of St Andrew Pl	SALB_150.5-182_A_EX	12	54	236
Beeson Ln	SALB_186-188_1_EX	6' x 6' RCB	8' x 6' RCB	631
Beeson Ln	SALB_186-188_2_EX	8' x 6.25' RCB	8' x 8' RCB	667
E Warner Ave	SALB_188-218_A_EX	36	48	60
E Warner Ave	SALB_188-218_1_EX	6' x 7' RCB	8' x 8' RCB	1206
Sub Area 6				
E St Andrew Pl	SALB_195-196_1_EX	36	72	810
E St Andrew Pl	Link277	-	60	76
S Lyon St	Link275	-	36	49
Sub Area 7				
Brookhollow Dr	SALB_218-223.5_A_EX	30	42	231
S Grand Ave	SALB_223.5-226_1_EX	8' x 10' RCB	10' x 10' RCB	1065
S Grand Ave	SALB_226-226.5_1_EX	8' x 10' RCB	10' x 10' RCB	448
S Grand Ave	SALB_226.5-280_1_EX	8' x 10' RCB	10' x 10' RCB	861
Sub Area 10				
Costa Mesa Fwy (SR-55)	SALB_226.5-280_2_EX	6' x 8' RCB	10' x 10' RCB	274
Tech Center Dr	SALB_276-279_2_EX	48	72	492
E Dyer Rd	SALB_276-279_3_EX	48	72	74
E Dyer Rd	SALB_276-279_4_EX	48	72	16
E Dyer Rd	SALB_276-279_5_EX	36	72	8
Hotel Terrace	SALB_279-280_1_EX	48	72	48
Hotel Terrace	SALB_279-280_2_EX	48	72	551
55 Fwy South	Link278	48	72	161
Sub Area 11				
Tech Center Dr	SALB_281-283_A_EX	18	36	34
Sub Area 13				
Southeast of E Columbine Ave	SALB_292-293_A_EX	21	60	131
Southeast of E Columbine Ave	SALB_292-293_1_EX	42	60	743
Sub Area 14				
1st American Way	SALB_296-296.5_A_EX	36	60	79
1st American Way	SALB_296-296.5_1_EX	54	60	270
Sub Area 15				
Evergreen St	SALB_266-270_1_EX	36	42	134
Evergreen St	SALB_266-270_2_EX	36	54	248
Emmett St	SALB_266-270_3_EX	36	54	233
Southeast of Emmett St	SALB_270-276_1_EX	36	54	322

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Southeast of Emmett St	SALB_270-276_2_EX	42	54	173
Southeast of Emmett St	SALB_274-276_A_EX	18	72	94
Southeast of Emmett St	SALB_274-276_B_EX	24	72	300
Southeast of Emmett St	SALB_276-279_1_EX	42	72	94
E Alton Ave	SALB_318-320_A_EX	36	48	20
E Columbine Ave	SALB_324-322_A_EX	18	36	289

7.3 Cost Estimates

Table 7-5 shows the proposed storm drain cost estimate summary. For detailed cost estimates see Appendix C.

Table 7-5: Lane-Barranca Proposed Storm Drain Cost Estimate

Lane-Barranca Proposed Storm Drain Cost Estimate	
Sub Areas	**Total Project Cost**
1-6	$11,483,000
7-10	$16,340,000
11-15	$2,848,000
Total	**$30,671,000**

8 Santa Ana Watershed

The Santa Ana Watershed lies within the City of Santa Ana. Santa Ana Watershed is approximately 3.89 sq. miles (2,488 acres). The watershed is generally bounded on the north by I-5 and SR-22, Washington Avenue on the south, Fairview Street on the west, and Tustin Avenue on the east. The Santa Ana Watershed is fully developed, consisting mainly of commercial and residential land use, and drains to the Santa Ana River.

Santiago Creek, a tributary to the Santa Ana River, flows through the Santa Ana Watershed. At the upstream end of the watershed, the gravel bottom Creek flows west through Santiago Park Nature Reserve. Several storm drain systems discussed below outlet into the creek before the Creek enters the Santa Ana River south of Memory Lane.

The watershed area east of the Topeka and Santa Fe Railway flows west into a storm drain that outlets into Santiago Creek west of SR-22. The area north of Santiago Creek and east of I-5 generally flows south. Flow from this area enters Santiago Creek through four separate systems. The 205 acre area east of I-5 and south of Santiago Creek flows west along surface streets toward I-5, where flows are picked up by a system that travels north into the Creek. There are three systems to the north of Santiago Creek west of I-5 and east of the Santa Ana River that drain into Santiago Creek. An additional Caltrans facility located within North Bristol Street adjacent to SR-22 drains the area to the north bounded by SR-22, I-5, and the Santa Ana River. The area north of Santa Clara Avenue and east of Flower Street flows west toward Flower Street, where flows are intercepted and taken north into the Creek via a storm drain system.

The storm drain system within 17th Street east of the Santa Ana River drains 509 acres of the watershed area. This system begins on the east side of I-5, where it travels west intercepting flows from the north before outletting into the Santa Ana River. A system on Washington Avenue to the south intercepts flows from the north and also flows west into the Santa Ana River. The Santa Ana River is in a slightly leveed condition near the outlets of these two systems. This has the potential to cause high tailwater issues, decreasing the capacity of the two systems to effectively drain storm flows.

Flows on the west side of the Santa Ana River that flow east are intercepted by five distinct storm drains. Some of the area to the north of Edna Drive is drained by three small separate residential storm drain systems tying directly into the Santa Ana River. There are two systems south of Edna Drive that drain the remaining area; one system within Fairview Street takes flows from the north into the Santa Ana River and the other system located at the southern terminus of Glenador Street also takes flows from the north into the Santa Ana River.

8.1 Existing Condition

The existing condition flood routing analyses were performed to identify existing street surface conveyance and storm drain capacities and to acquire a benchmark for the proposed analyses. The 10- and 100-year annual chance models were then calculated to develop a basis for the evaluation and development of potential drainage improvements.

In this study the following updates were made to the SDMP Phase 1 hydrology delineation and/or storm drain geometry. This update/revision is to further define the drainage pattern. Figure 8-1 shows the Santa Ana watershed subarea map.

Subarea 1

1. Revised hydrology into MH-534 in order to be a hydrograph instead of constant inflow. The small area hydrograph for this node was generated consistent with OCHM.

Subarea 6.2

1. Revised hydrology into MH-411 in order to be a hydrograph instead of constant inflow. The small area hydrograph for this node was generated consistent with OCHM.

Subarea 9

1. Revised hydrology into MH_(Point)-2294 in order to be a hydrograph instead of constant inflow. The small area hydrograph for this node was generated consistent with OCHM.

Subarea 10

1. Added existing line north of SR-22 freeway along Bristol. Revised hydrology, removing the area north of SR-22 freeway from the hydrograph in CB-33, and adding this area into the corresponding catch basin (Node448) in the new line.

Subarea 10

1. Added existing line south of SR-22 freeway along Sawgrass Drive and revised hydrology accordingly, reducing flow into CB-34 and CB-33.

Subarea 11

1. Revised hydrology North of Westminster and West of the Santa Ana River to account for existing storm drains based on OC facility maps that outfall into the Santa Ana River.

Subarea 13

1. Revised hydrology into node MH(point)-2286 in order to be flow hydrograph instead of constant inflow. The small area hydrograph for this node was generated using AES.
2. Removed constant inflow from MH-587 and CB-64. There was no corresponding node on the hydrology map.

Subarea 16

1. Revised hydrology into OF-15 in order to be a hydrograph instead of constant inflow. The small area hydrograph for this node was generated consistent with OCHM.
2. Revised hydrology into CB-54 to remove area East of Flower based on new delineation and topographic information.
3. Split CB-56 into three catch basins; CB-56 and two additional catch basins north of the baseball field (Node442 and Node443). Divided flow evenly into all three.

Subarea 18

1. Added existing storm drain line along River Lane just north of Santiago Creek based on OC facility map.

Subarea 20

1. Revised hydrology into MH-587 in order to be a hydrograph instead of constant inflow. The small area hydrograph for this node was generated consistent with OCHM.

Global

10-year Models

1. Removed constant backwater on pipes that outfall into Santa Ana River and Santiago Creek and let the river hydraulics determine the backwater effects.
2. Added in flow boundaries into the Santa Ana River and Santiago Creek to model the backwater effect more accurately. The flow rates for the Santa Ana River and Santiago Creek were taken from the FEMA FIS and applied directly to the 2D surface via flow boundaries. This allows backwater elevations acting on pipes draining into these channels to be calculated using the 2D surface.

100-year Models

1. Due to instabilities in the 100-year models caused by high inflow hydrographs, the Santa Ana River was modeled in 1D, while the rest of the watershed was modeled in 2D. This was necessary due to the unrealistic flooding throughout the entire watershed. By modeling the river in 1D, the results produced were much more realistic.
2. The downstream control of the Santa Ana River was set as the normal depth calculated using the cross section of the Santa Ana River and the flow from the FEMA FIS study. The normal depth was calculated to be 7.05 feet.

8.1.1 Existing Condition Results

A description of the major flooding areas within the Santa Ana watershed shown in the 10-year and 100-year existing models are discussed below. Figure 8-2 and Figure 8-3 show the 10-year and 100-year existing condition maximum depth results. Figure 8-4 and Figure 8-5 show the 10-year and 100-year existing condition duration of inundation maps.

Subarea 3

The intersection of 22nd Street and Spurgeon Street (east of the I-5 Freeway), extensive neighborhood flooding is caused by a single undersized catch basin along 22nd Street. The main line has enough capacity to convey the additional flow that the existing catch basin does not capture.

Subarea 9

An undersized catch basin and associated laterals at the intersection of Flower St. and Memory Lane causes street flooding along Memory Lane in the 10-year scenario.

Subarea 10

Flooding along Bristol Avenue south of SR-22 Freeway and north of Santiago Creek is due to two deficient storm drain lines and associated catch basins. The storm drain located within Bristol Street under the SR-22 Freeway is owned by Caltrans and carries flow from the area bounded by the SR-22 Freeway, I-5 Freeway, and Santa Ana River. In the 10-year scenario, this facility is unable to carry all of the flow from this area, which then continues south along Bristol and causing flooding. The flooding along Bristol Street is also caused by undersized storm drain and catch basins along Bristol Street from Santiago Creek to Riverglen Lane. The lack of capacity in this storm drain causes the flooding within the housing development north of Memory Lane and east of the Santa Ana River. Additionally, River Lane is flooded by this storm drain line.

Subarea 12

Flooding in the area south of Westminster Avenue and west of Fairview Street on the west side of the Santa Ana River is caused by an undersized storm drain mainline and several catch basins and laterals. This storm drain system drains a large area west of the Santa Ana River and does not have enough capacity to capture the discharge from the tributary area.

Subarea 14

The main backbone storm drain system within the Santa Ana Watershed is along 17th Street, east of the Santa Ana River and west of the Interstate 5 (I-5) Freeway. This facility drains a large area of 582 acres and is undersized in the 10-year and 100-year scenario. The main line is at a very flat slope of 0.27%, making it difficult to convey large discharge. Complicating this issue, there is a high tailwater condition at the outlet into the Santa Ana River. The river is in a partially leveed condition at this location, meaning the River is capable of flowing at a water surface elevation higher than the ground elevation on the dry side of the levee. This can result in water in the streets being unable to enter the storm drain system.

The catch basins and laterals located near Bristol Street and 17th Street are unable to capture all of the flow, which then floods 17th Street and Santa Ana College. Additionally, the water surface within the main line reduces the ability of the incoming lateral to convey flow into the main line. Further upstream along this line, several more catch basins and laterals are undersized causing local street flooding.

The area bounded by West Santa Clara Avenue, North Bristol Street, 17th Street, and North Flower Street experiences street flooding in the 10-year scenario. This is caused by a deficient storm drain main line and catch basins within Flower Street flowing north into Santiago Creek from Santa Clara Avenue.

Subarea 16

Small amounts of local street flooding south of Washington Avenue are caused by a few undersized catch basins and laterals. The existing main line within Washington Avenue is sized large enough to convey the additional flow that would be added by upsizing catch basins and laterals.

8.1.1.1 Santa Ana Model Validation

The Santa Ana model was validated using the base flood elevations provided in the FEMA FIRM map. The water surface elevation was compared within the Santiago Creek Channel just upstream of the confluence with the Santa Ana River. At this location, the base flood elevation was shown to be 110 feet in the FIRM. The 100 year existing condition model showed a water surface elevation within 1 foot of accuracy to the FIRM.

The model was further validated by comparing flooding at the intersection of Bristol St and 17th St. Photos were taken at the intersection during the January 12, 2017 storm showing 1-2 feet of flooding (see Section 8.1.2). This storm, according to some estimates was between a 10- and 25-year storm event. Both the 10-year and 100-year show flooding of 1-2 feet in that intersection.

8.1.2 <u>Street Deficiency</u>

Of the nodes which remain flooded in the existing condition, some of these nodes result in street deficiencies while the magnitude of flooding in other nodes do not result in street deficiencies. Streets are defined as being deficient if the max depth at a node/street is greater than the max allowable design protection. The 2D flooding inundation extent was used in conjunction with the 1D hydraulics to determine the street deficiency.

By comparing the magnitude of the maximum depth at each node and the 2D overland flooding which remains flooded in the existing condition with the max allowable depth according to each typical street section, streets are deficient at the following node locations shown on Table 8-1Table 4-1 and Table 8-2.

Table 8-1: Santa Ana Street Deficiencies Per Max Allowable Flow (100-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
CB-33	Bristol St	@ SR-22	Arterial (120')	2.344	0.85
CB-34	Bristol St	@ Park Lane	Arterial (120')	1.362	0.85
MH-466	Bristol St	N of Memory Lane	Arterial (120')	1.3	0.85
MH-582	Bush Street	W of Spurgeon Street	Local	1.58	0.71
CB-19	Santa Clara Ave	@ Flower Street	Local	1.018	0.71
CB-16	W 17th Street	W of Santiago Street	Arterial (120')	1.566	0.85
CB-44	W 17th Street	@ Greenfield Street	Arterial (120')	0.962	0.85
CB-45	W 17th Street	@ Flower Street	Arterial (120')	0.902	0.85
CB-47	W 17th Street	@ Westwood Ave	Arterial (120')	0.98	0.85
CB-48	W 17th Street	@ Baker Street	Arterial (120')	1.493	0.85
CB-49	W 17th Street	@ Bristol Ave	Arterial (120')	3.044	0.85
CB-53.1	W 17th Street	@ English Street	Arterial (120')	1.047	0.85
MH-439	W 17th Street	@ I-5	Arterial (120')	1.283	0.85
MH-440	W 17th Street	@ I-5	Arterial (120')	1.56	0.85
MH-453	W 17th Street	E of Bristol Marketplace	Arterial (120')	1.595	0.85
SD-MH_(Point)-2041	W 17th Street	@ Bristol Ave	Arterial (120')	0.914	0.85
CB-36	Westminster Ave	@ Sydney Street	Arterial (120')	1.528	0.85

Table 8-2: Santa Ana Street Deficiencies Per Max Allowable Flow (10-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
CB-36	Westminster Ave	@ Sydney Street	Local	1.077	0.5
CB-45	W 17th Street	@ Flower Street	Arterial (120')	0.92	0.73
CB-47	W 17th Street	@ Westwood Ave	Arterial (120')	1.054	0.73
CB-48	W 17th Street	@ Baker Street	Arterial (120')	0.985	0.73
CB-49	W 17th Street	@ Bristol Ave	Arterial (120')	2.384	0.73
CB-53.1	W 17th Street	@ English Street	Arterial (120')	0.889	0.73
MH-453	W 17th Street	E of Bristol Marketplace	Arterial (120')	1.191	0.73

8.1.3 Known Flooding Area and Winter 2017 Storms

City of Santa Ana has known historic flooding locations within the Santa Ana watershed. Some of these locations experienced significant flooding during the 2017 winter season especially the January 22, 2017 storm. According to some estimates the storm event was estimated between 10- and 25-year. The flooding locations were observed and documented by the city maintenance crew and some locations were identified based on social media research, i.e., twitter feeds and resident complaints. These flooding locations within the Santa Ana watershed include:

Bristol St. and 17th St.

On January 12, 2017 there were complaints of flooding from Bristol St. and 17th to Bristol St. and San Ana Channel (Santiago Creek). Storm drains were at capacity from all the flooding that it was only able to take in so much at a time during the heavy rainfall.

Bristol and 17th Street – January 12, 2017 Storm

Santa Clara Ave. and Broadway

There is an area within the Santa Ana watershed which has been previously indicated by the City to be a known flooded area. This area is in the vicinity of the intersection between Santa Clara Ave. and Broadway. At this location, it has been confirmed by City as-builts that there is an existing under sidewalk box culvert system.

Flower St. and 17th St.

Flooding has been observed at the intersection of Flower Street and 17^{th} Street.

Flower and 17th Street

Fairview St. and Downie Pl.

Everything at this location flows West toward Garden Grove. Significant flooding was observed at the cross gutter at the intersection. Downie St (West of Fairview) was completely underwater. This area is within the City of Garden Grove.

Fairview Street and Downie Place – January 5, 2016 Storm

Fairview St. and Trask Ave.

Flooding was observed by the city at the intersection of Trask and Fairview. Water was backed up along Trask Avenue, east of Fairview Street.

8.2 Proposed Condition

A description of the proposed improvement areas within the Santa Ana watershed are discussed below. For a compiled list of proposed improvements, see Table 8-3 and Table 8-4. Figure 8-6 and Figure 8-7 show the 10-year and 100-year proposed condition maximum depth results. Figure 8-8 and Figure 8-9 show the 10-year and 100-year proposed condition duration of inundation maps. Figure 8-10 and Figure 8-11 show the 10-year and 100-year difference (existing vs proposed) depth maps. Figure 8-12 through Figure 8-19 show the proposed facilities.

Subarea 3

The flooding at the intersection of Spurgeon Street and 22nd Street is caused by undersized catch basins. Adding two 28' catch basins in this area removes most of this flooding. The main line that these catch basins drain into is appropriately sized.

Subarea 9

Shallow ponding near the intersection of Memory Lane and Flower Street is caused by deficient catch basins and associated laterals. The main line that drains into Santiago Creek is appropriate sized. Improving these catch basins and laterals is enough to improve this area.

Subarea 10

The storm drain line within Bristol Street north of Santiago Creek is a significant contributor to the flooding issues north of the Creek. Adding two additional parallel RCPs south of Memory Lane and one additional parallel RCP north of Memory Lane while upsizing the catch basins near Park Lane and north of Riverglen Lane relieves most of the problematic flooding in the area.

Subarea 12

The flooding near Westminster Avenue and Fairview Street can be improved by upsizing the storm drain line along Westminster and Fairview and adding additional catch basins. This also prevents flows from continuing south and flooding Glenarbor Street and Mar Les Drive along the Santa Ana River.

Subarea 13

The catch basins at the intersection of Santa Clara Avenue and Flower Street are unable to capture all of the flow in this area, which then travels southwesterly and contributes to the ponding in 17th Street. Upsizing these catch basins and increasing the size of the storm drain that drains into Santiago Creek reduces the flooding.

Subarea 14

Due to the mild street slope, the main storm drain line along 17th Street is undersized. This line is the main factor contributing to the flooding south of 17th Street. Improving this main line lessens the extent of flooding over a large area, including the entire campus of Santa Ana College, Bristol Street, English Street, and Washington Avenue east of Bristol Street to Main Street. West of Baker Street, the recommendation is to add an additional 3 parallel RCB, bringing the total number of RCBs within 17th

Street to 4. East of Baker Street, it is recommended to upsize the existing RCP. Seven catch basins along 17th Street are also recommended to be upsized.

Subarea 15

The arched storm drain line that drains from western 21st Street into the Santa Ana River is undersized, causing flows to travel south along Alona Street and ponding in 17th Street. Upsizing the catch basins at the intersection of Alona Street and 21st Street allows the additional flow to enter the storm drain. Adding a parallel arch culvert or a parallel RCP provides enough pipe capacity to drain this area.

Subarea 16

Upsizing five catch basins along Washington Avenue and extending the line 300 ft east of Bristol Street improves the ponding along Washington Avenue west of Bristol Street. This also prevents ponding along 12th Street, as excess flows from Washington Avenue continue south along English Street and King Street before ponding along 12th Street.

Subarea 17

Shallow ponding near the intersection of Fairview Street and Civic Center Drive is caused by an undersized storm drain line that drains into the Santa Ana River. Installing a parallel pipe along the existing pipe and upsizing the catch basins dramatically improves the flooding.

8.2.1 Drainage Improvements

8.2.1.1 Santa Ana Catch Basins

Table 8-3 lists which catch basins are recommended for improvement. Details on existing and proposed catch basin sizes can be found in Appendix F.

Table 8-3: Santa Ana Proposed Upsized Catch Basins

Sub Area 3
CB-24
Sub Area 9
CB-32
Sub Area 10
CB-34, CB-33
Sub Area 11
CB-35, CB-36
Sub Area 13
CB-19, CB-19.5
Sub Area 14 (1 OF 2)
CB-41, CB-43,CB-45
Sub Area 14 (2 OF 2)
CB-46, CB-47, CB-48, CB-51, CB-52
Sub Area 15
CB-50
Sub Area 16
Node440*, CB-55, CB-57, Node444*, CB-58
Sub Area 17
CB-59

8.2.1.2 Santa Ana Proposed SD Improvements

Table 8-4 lists the recommended storm drain improvements. Details on cost estimates can be found in Appendix C.

Table 8-4: Santa Ana Proposed Storm Drains

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 9				
N Flower St	SASA_382-383_A_EX	18	36	64
Sub Area 10				
N Bristol	SASA_389-396_1_EX	48	2-48	797
N Bristol	SASA_389-396_2_EX	60	2-60	478
N Bristol	SASA_389-396_3_EX	60	2-60	417
N Bristol	SASA_395-396_A_EX	30	42	45
N Bristol	SASA_396-397_1_EX	66	2-66	869
Sub Area 11				
Westminster Ave	SASA_415-416_A_EX	18	30	35
Westminster Ave	SASA_415-416_1_EX	24	36	378
Westminster Ave	SASA_416-420_1_EX	24	36	293
Westminster Ave	SASA_416-420_2_EX	30	36	56
Westminster Ave	SASA_420-421_1_EX	42	48	506
Westminster Ave	SASA_411-421_A_EX	51	51	51
Fairview St	SASA_421-422_1_EX	60	72	945
Sub Area 13				
W Santa Clara Ave	SASA_432-433_A_EX	18	36	32
W Santa Clara Ave	SASA_432-433_B_EX	18	30	12
W Santa Clara Ave	SASA_433-434_1_EX	18	48	97
N Flower St	SASA_433-434_2_EX	30	60	1232
Sub Area 14 (1 of 2)				
E 17th St	SASA_363-438_A_EX	36	2-36	39
E 17th St	SASA_363-438_1_EX	36	2-36	99
E 17th St	SASA_363-438_2_EX	36	2-36	110
E 17th St	SASA_363-438_3_EX	36	54	790
E 17th St	SASA_363-438_4_EX	36	54	170
E 17th St	SASA_438-442_1_EX	36	54	417
E 17th St	SASA_442-447_1_EX	36	60	363
E 17th St	SASA_447-452_1_EX	36	60	629
E 17th St	SASA_451-452_A_EX	30	48	15
E 17th St	SASA_452-458_1_EX	39	60	576
E 17th St	SASA_452-458_2_EX	39	60	285
E 17th St	SASA_457-458_A_EX	18	48	15
E 17th St	SASA_458-463_1_EX	42	60	432
E 17th St	SASA_463-468_1_EX	48	60	741
Sub Area 14 (2 of 2)				
E 17th St	SASA_468-473_1_EX	36	60	1180
N Westwood Ave	SASA_477-478_A_EX	36	36	15~
N Baker St	SASA_482-483_A_EX	36	48	15
E 17th St	SASA_472-473_A_EX	36	2-36	15

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
N Bristol St	SASA_487-488_A_EX	36	2-36	15
Sub Area 15				
Alona St	SASA_494-495_A_EX	2-58" x 36" Corrugated Metal Arch	2-58.5" x 36" Corrugated Metal Arch	65
Alona St	SASA_495-496_1_EX	2-58" x 36" Corrugated Metal Arch	2-59" x 81" Corrugated Metal Arch	589
Alona St	SASA_495-496_2_EX	2-58" x 36" Corrugated Metal Arch	2-59" x 81" Corrugated Metal Arch	132
Sub Area 16				
W Washington Ave	SASA_514-515_A_EX	18	66	15
W Washington Ave	Link265*	-	42	14
W Washington Ave	Link266*	-	42	223
N King St	SASA_533-534_A_EX	21	30	18
N Baker St	Link281*	-	6’ x 4’ RCB	2701
N Baker St	Link266*	-	6’ x 4’ RCB	223
Sub Area 17				
Fairview St	SASA_539-540_A_EX	36	48	15
West of Civic Center Dr	SASA_540-541_1_EX	48	2- 48" RCP	901

*New Pipe
~Slope change

8.3 Cost Estimates

Table 8-5 shows the proposed storm drain cost estimate summary. For detailed cost estimates see Appendix C.

Table 8-5: Santa Ana Proposed Storm Drain Cost Estimate

Santa Ana Proposed Storm Drain Cost Estimate	
Sub Areas	**Total Project Cost**
1	$0
2-8	$0
9, 10, 13, 18 & 19	$3,660,000
11, 12	$1,988,000
14 (1 of 2)	$4,255,000
14 (2 of 2)	$1,978,000
16, 17 & 20	$3,455,000
Total	**$15,336,000**

9 Santa Fe- Grand

The Santa Fe Grand watershed within the City of Santa Ana is approximately 1.4 sq. miles (921 acres). The watershed is bounded by Fairhaven Avenue to the north, Lincoln Avenue, North Hathaway Street, Terminal Street, and North Grand Avenue to the west, the Santa Fe Channel to the south, and Fairhaven Memorial Park, Mantle Lane, Linwood Avenue, and Lyon Street to the east. The watershed consists of one storm drain system that is tributary to the Santa Fe Channel.

The existing storm drain system ranges in size from 12-ines to 90-ines. Runoff flows south and east. The watershed is split by the 5 Freeway which runs from northwest to southeast.

9.1 Existing Condition

The existing condition flood routing analyses were performed to identify existing street surface conveyance and storm drain capacities and to acquire a benchmark for the proposed analyses. The 10- and 100-year annual chance models were then calculated to develop a basis for the evaluation and development of potential drainage improvements.

In this study the following updates were made to the SDMP Phase 1 hydrology delineation and/or storm drain geometry. This update/revision is to further define the drainage pattern. Figure 9-1 shows the Santa Fe- Grand watershed subarea map.

Subarea 6

1. The storm drain system on Grand Ave. (between 4th and 1st) is shown as an 84-in pipe on the OC facilities map as well as as-built HF 18-55. The previous model showed two storm drain systems the 84-in pipe and a 78-in pipe. No evidence was found showing two systems, so the 78-in storm drain system was deactivated in the model.
2. The storm drain system that follows the rail road tracks just west of Grand Avenue was updated to join directly to the mainline system, as shown in as-builts, before outletting to the channel. This was changed from where it joined the catch basin in the previous model.

Santa Ana-Santa Fe Channel Tailwater

The methodology used in the SDMP Phase 1 was determined to provide the most realistic tail water to be used in the model. The tailwater was taken from a WSPG model that utilized the flowrate from the CivilStorm model. The flowrates were determined to be 512 cfs and 669 cfs for the 10-year and 100-year model, respectively. This provided a tailwater depth of 7.58’ and 8.41’ for the 10-year and 100-year, respectively.

9.1.1 Existing Condition Results

A description of the major flooding areas within the Santa Fe-Grand watershed shown in the 10-year and 100-year existing models are discussed below. Figure 9-2 and Figure 9-3 show the 10-year and 100-year existing condition maximum depth results. Figure 9-4 and Figure 9-5 show the 10-year and 100-year existing condition duration of inundation maps.

Subarea 1

Flooding along Old Grand Street originates just south of the intersection with Cherry Street and is caused by an undersized catch basin as well as the deficient storm drain system that runs south on Old Grand Street and west on East Santa Clara Avenue before joining the mainline on Lincoln Avenue.

Subarea 3

The deficient storm drain line along East Santa Clara Avenue causes flooding on Santa Clara and North Grand Avenue, where it travels south and west to 21st Street and 17th Street. This area is considered a priority due to the proximity to the proximity to Trinity Law School as well as the post office.

The storm drain mainline system along Lincoln Avenue is deficient, with the most upstream catch basin also deficient. This causes flooding at the intersection of Brynwood Street and Joana Drive. The flow travels south and west before ponding at the cul-de-sacs of multiple residential streets.

Significant flooding occurs at the intersection of 21st Street and North Eastwood Avenue, with water depths greater than 1 ft. This flooding is caused by an undersized catch basin at that intersection and the deficient storm drain line along Lincoln Avenue. In addition, the flow from the deficient storm drain system along Santa Clara Avenue contributes to the flooding. The flow travels south west onto Lincoln Avenue and 17th Street. The storm drain systems along Lincoln Avenue and North Grand Avenue are of importance due to the proximity to a college and a school.

In addition to the flooding on 17th Street due to the deficient systems on Lincoln Avenue and Santa Clara Avenue, additional flooding is caused by two deficient systems along 17th street. The first is the storm drain mainline system along Lincoln Avenue that turns east on 17th street before heading south on North Grand Avenue.

Subarea 4

The second deficient storm drain along 17th street begins at the intersection with North Wright Street, where the catch basin is also undersized, and then confluences with the mainline at North Grand Avenue. The deficient catch basin at the intersection of North Wright Street and 17th Avenue also contributes to flooding that flows southwest on North Linwood Avenue and 15th street.

Subarea 5

In the downstream portion of the watershed, there are two locations of flooding less than half a foot on East 4th Street. The first is at the intersection with North McClay Street and is caused by an undersized catch basin. This location is a priority due to its proximity to Frederick Remington Elementary School. The second is at the intersection with Terminal Street and is caused by the deficient storm drain line that begins at that intersection runs east on 4th Street before confluencing with the mainline storm drain on North Grand Avenue and heading south.

Subarea 6

South of East First Street on South Grand Avenue as well as along the railroad tracks to the west there is flooding with depths varying from less than half a ft to greater than 1 ft. The flooding is caused by two deficient storm drain systems, one on Grand Avenue and the other along the railroad tracks. Both storm drain lines outlet into the Santa Fe Channel. The Santa Fe Channel is undersized and therefore contributes to the flooding due to backwater effect.

9.1.1.1 Santa Fe- Grand Model Validation

There is no data available to validate the existing model.

9.1.2 Street Deficiency

Of the nodes which remain flooded in the existing condition, some of these nodes result in street deficiencies while the magnitude of flooding in other nodes do not result in street deficiencies. Streets are defined as being deficient if the max depth at a node/street is greater than the max allowable design protection. The 2D flooding inundation extent was used in conjunction with the 1D hydraulics to determine the street deficiency.

By comparing the magnitude of the maximum depth at each node and the 2D overland flooding which remains flooded in the existing condition with the max allowable depth according to each typical street section. There are no deficient streets in this watershed.

9.1.3 Known Flooding Area and Winter 2017 Storms

N Wright St. (Between E. Santa Clara Ave. and 17th St.)

During the storm on January 5th, 2017, water was observed running south on Wright from Santa Clara Ave. to 17th Street taking up nearly half a lane. The nearest catch basin is on 17th and Wright.

9.2 Proposed Condition

A description of the proposed improvement areas within the Santa Fe Grand watershed are discussed below. For a compiled list of proposed improvements, see Table 9-1 and Table 9-2. Figure 9-6 and Figure 9-7 show the 10-year and 100-year proposed condition maximum depth results. Figure 9-8 and Figure 9-9 show the 10-year and 100-year proposed condition duration of inundation maps. Figure 9-10 and Figure 9-11 show the 10-year and 100-year difference (existing vs proposed) depth maps. Figure 9-12 through Figure 9-14 show the proposed facilities.

Subarea 1

Flooding along Old Grand Street can be significantly reduced by upsizing the storm drain line along Old Grand Street and along East Santa Clara Avenue. Additionally, upsizing the catch basin at the storm drain headworks as well as adding a catch basin and associated lateral on the southeast corner of North Grand Avenue and Santa Clara Avenue can help alleviate flooding.

Subarea 2

The flooding at the mainline system along Lincoln Avenue can be eliminated by upsizing the catch basin and associated lateral at the intersection of Brynwood Street and Joana Drive as well as the mainline storm drain on Lincoln Avenue.

Subarea 3

Flooding at the intersection of 21st Street and North Eastwood Avenue can be greatly reduced by upsizing the catch basin and associated lateral in addition to upsizing the mainline on Lincoln Avenue as described above.

The flooding on 17th street caused by the two deficient storm drains along 17th can be significantly reduced by upsizing the catch basin at the headworks of the western storm drain system.

Subarea 4

Upsizing the eastern storm drain system on 17th Street will also assist in alleviating flooding.

Subarea 5

The flooding on East 4th street can be eliminated by upsizing the catch basin at the system headworks of the eastern leg of the storm drain system on 4th Street as well as upsizing the western system.

Subarea 6

The flooding South of East First Street on South Grand Avenue as well as along the railroad tracks to the west can be reduced by upsizing the catch basin just east of the intersection of Santa Fe Street and East Chestnut Avenue as well as upsizing the storm drain system that follows the railroad tracks. Also upsizing the storm drain along Grand Avenue will assist in reducing the flooding. It is important to note that both of these storm drains outlet to the Santa Fe Channel, which is undersized and therefore contributes to the flooding due to backwater effect. It is recommended that the channel be upsized prior to any other improvements.

9.2.1 Drainage Improvements

9.2.1.1 Santa Fe Grand Catch Basins

Table 9-1 lists which catch basins are recommended for improvement. Details on existing and proposed catch basin sizes can be found in Appendix F.

Table 9-1 Santa Fe Grand Proposed Upsized Catch Basins

Sub Area 1
CB-572, CB-772, CB-72*
Sub Area 2
CB-1919
Sub Area 3
CB-31
Sub Area 4
CB-13
Sub Area 5
CB-1885
Sub Area 6
CB-32, CB-30

* New catch basin

9.2.1.2 Santa Fe Grand Proposed SD Improvements

Table 9-2: Santa Fe Grand Proposed Storm Drains

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
Old Grand St	SASF_GA_113-114_A_EX	27	54	63
Old Grand St	SASF_GA_114-115_1_EX	27	54	362
Old Grand St	SASF_GA_114-115_2_EX	27	54	366
Old Grand St	SASF_GA_114-115_A_EX	24	36	24
Sub Area 2				
E Santa Clara Ave	SASF_GA_114-115_3_EX	39	60	144
E Santa Clara Ave	SASF_GA_115-122_1_EX	3-24	60	317

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
E Santa Clara Ave	Link77*	-	24	124
E Santa Clara Ave	SASF_GA_122-123_1_EX	39	60	668
E Santa Clara Ave	SASF_GA_123-124_1_EX	48	60	619
Lincoln Ave	SASF_GA_128-130_A_EX	24	36	20
Lincoln Ave	SASF_GA_128-130_1_EX	24	36	280
Lincoln Ave	SASF_GA_130-131_1_EX	24	36	251
Lincoln Ave	SASF_GA_131-124_1_EX	24	36	427
Sub Area 3				
Lincoln Ave	SASF_GA_124-132_1_EX	54	72	197
Lincoln Ave	SASF_GA_132-157_1_EX	57	72	1334
N Eastwood Ave	SASF_GA_156-157_A_EX	12	36	173
Lincoln Ave	SASF_GA_157-157.5_1_EX	66	96	1089
E 17th St	SASF_GA_157-157.5_2_EX	72	96	586
E 17th St	SASF_GA_157.5-158_1_EX	75	96	489
E 17th St	SASF_GA_157.5-158_2_EX	75	96	91
Sub Area 4				
E 17th St	SASF_GA_146-147_A_EX	36	48	13
E 17th St	SASF_GA_146-147_1_EX	36	48	415
E 17th St	SASF_GA_146-147_2_EX	36	54	121
E 17th St	SASF_GA_147-148_1_EX	36	60	333
E 17th St	SASF_GA_147-148_2_EX	36	60	521
E 17th St	SASF_GA_148-158_1_EX	36	60	91
Sub Area 5				
E 17th St	SASF_GA_177-178_A_EX	36	54	66
E 17th St	SASF_GA_177-178_1_EX	36	60	256
E 17th St	SASF_GA_178-179_1_EX	36	60	391
E 17th St	SASF_GA_180-169_1_EX	42	60	271
Sub Area 6				
S Grand Ave	SASF_GA_169-181_3_EX	90	8' x 8' RCB	276
S Grand Ave	SASF_GA_181-182_1_EX	90	8' x 8' RCB	862
S Grand Ave	SASF_GA_182-184_1_EX	90	8' x 8' RCB	472
S Grand Ave	SASF_GA_182-184_2_EX	90	8' x 8' RCB	797
S Grand Ave	SASF_GA_183-184_4_EX	30	42	77
S Grand Ave	SASF_GA_184-185_1_EX	90	8' x 8' RCB	133
Railroad east of Santa Fe St	SASF_GA_183-184_1_EX	36	42	714
Railroad east of Santa Fe St	SASF_GA_183-184_2_EX	36	42	453
Railroad east of Santa Fe St	SASF_GA_183-184_3_EX/Link76	42	48	365

* = New storm drain

9.3 Cost Estimates

Table 9-3 shows the proposed storm drain cost estimate summary. For detailed cost estimates see Appendix C.

Table 9-3: Santa Fe Grand Proposed Storm Drain Cost Estimate

Santa Fe Grand Proposed Storm Drain Cost Estimate	
Sub Areas	**Total Project Cost**
1-4	$9,545,000
5-6	$12,299,000
Total	**$21,844,000**

10 Santa Fe-Tustin

The Santa Fe Tustin watershed within the City of Santa Ana is approximately 1.7 sq. miles (1087 acres). The watershed is bounded by SR-22 to the north, SR-55 to the east, the Santa Fe Channel to the south, and Fairhaven Memorial Park, Mantle Lane, Linwood Avenue, and Lyon Street to the west. The watershed consists of three (3) storm drain systems; (1) Tustin Mainline System, (2) Village Way System, and (3) Tustin East System. The Tustin Mainline System and Tustin East System are both tributary to the Santa Fe Channel. The Tustin East System is tributary to the City of Tustin storm drain line. Runoff generally flows south west.

The Tustin Mainline System has a tributary area of 894 acres which makes up 82% of the total watershed. The existing system ranges in size from an 18-in RCP to a 13' x 10' RCB.

The Village Way System has a tributary area of 66 acres which makes up roughly 6% of the total watershed. The existing storm drain system is 36-ines.

The Tustin East System has a tributary area of 127 acres which makes up 12% of the total watershed. The existing system is 33-ines.

10.1 Existing Condition

The existing condition flood routing analyses were performed to identify existing street surface conveyance and storm drain capacities and to acquire a benchmark for the proposed analyses. The 10- and 100-year annual chance models were then calculated to develop a basis for the evaluation and development of potential drainage improvements.

In this study the following updates were made to the SDMP Phase 1 hydrology delineation and/or storm drain geometry. This update/revision is to further define the drainage pattern. Figure 10-1 shows the Santa Fe-Tustin watershed subarea map.

Subarea 1

1. Updated storm drain system on 17th and Old Tustin Road and 17th and Williams to reflect as-builts. For the laterals, the slopes were assumed based on the slope of the street.
2. Near 4th St. and Cabrillo Park Drive, there were catch basins with constant inflow. Therefore, the hydrology was updated to get inflow hydrographs for the hydraulic model. In addition, two catch basins were found on Google Earth that was not included in the Phase 1 model. Therefore, the catch basins (CB-171) were combined (7' + 14' based on Google Earth) and added on 4th St. between Cabrillo Park Drive and North Golden Circle Drive. Due to the lack of information in the OC facilities map, the lateral was assumed to be a 24-in RCP and the slope was based on the street. Two other catch basins (CB-172,173) were added at the intersection of 4th and Cabrillo Park Dr. that were found in Google Earth. Due to the lack of information in the OC Facilities map, the laterals were assumed to be 18-in RCPs and the slope was based on the slope of the street. Both catch basins were 7-ft based on Google Earth. Another 7-ft catch basin (CB-174) was found on Google Earth on 1st Street between Cabrillo Park Drive and North Golden Circle Dr. The lateral was assumed to be an 18-in RCP and the slope was based on the slope of the street.
3. A catch basin (CB-175) was found on Google Earth at the most southern portion of North Golden Circle Drive. The catch basin drains to the open concrete channel that continues as a 72-in RCP under the 5 FWY. This was done so that the updated hydrograph could be added appropriately. The catch basin was determined to be 7' based on Google Earth. Due to the lack of information

in the OC Facilities map, the lateral was assumed to be an 18 in RCP and the slope was based on the slope of the parking lot tributary to the catch basin.

4. Catch basin (CB-179) found on the north side of 17th street just west of Williams Street. Location was confirmed in as-builts but did not have lateral or catch basin size information. The catch basin was determined to be 7' based on Google Earth and due to the lack of information in the OC Facilities map, the lateral was assumed to be 18 in and the slope was based on the slope of the street.
5. Converted the constant inflow in MH-492 to a hydrograph. The small area hydrograph for this node was generated using AES.
6. Converted the constant inflow in MH-1393 to a hydrograph. The small area hydrograph for this node was generated using AES.
7. Converted the constant inflow in MH-1561 to a hydrograph. The small area hydrograph for this node was generated using AES.
8. Converted the constant inflow in MH-2169 to a hydrograph. The small area hydrograph for this node was generated using AES.

Subarea 2

1. Could not find as- builts for storm drain on North Tustin road, south of 17th. Used slope of road and size stated on OC facilities map. Google Earth was used for catch basin size.
2. Two catch basins (CB-176 (14'), CB-177 (7')) were found on Google Earth and confirmed in as-builts on 17th Street at the intersection with N. Tustin Ave. These were added to the model. The laterals were assumed to be 18 in and the slopes were based on the street.
3. Found a catch basin on the corner of N. Tustin Ave. and Bentall Center. The as-builts were used to determine the catch basin and lateral size and the inverts and slope of the lateral.
4. Converted the constant inflow in MH-480 to a hydrograph. The small area hydrograph for this node was generated using AES.

Subarea 3

1. Converted the constant inflow in MH-1340 to a hydrograph. The small area hydrograph for this node was generated using AES.
2. MH-1325 had the 100-year hydrograph in the 10-year model. The 10-year model was updated to include the 10-year hydrograph in this node.

Outfall Tailwater

The tailwater for the Santa Fe Channel was assumed to be 1-ft below the top of channel for the 100-yr storm event. This method was selected due to the fact that when the depth determined from the SDMP Phase 1 was applied at the downstream head boundary, the water surface elevation would be above the top of channel. For the 10-year storm events the depth of 12.31 ft from the SDMP Phase 1 was used and applied as a head boundary downstream of the outfall location. This will allow the 2D model to calculate the water surface of the channel while still implementing the tailwater.

10.1.1 Existing Condition Results

A description of the major flooding areas within the Santa Fe Tustin watershed shown in the 10-year and 100-year existing models are discussed below. Figure 10-2 and Figure 10-3 show the 10-year and 100-year existing condition maximum depth results. Figure 10-4 and Figure 10-5 show the 10-year and 100-year existing condition duration of inundation maps.

Subarea 1

In the existing condition scenario, 10-year flows are enough to exceed the capacity of catch basins located at the intersection of Tustin Avenue and Fairhaven Avenue and the intersection of Fairhaven Avenue and Ponderosa Street. Excess flows travel south along Tustin Avenue and Ponderosa Street, resulting in minor ponding. There is, however, enough capacity in the main lines and laterals to convey the 10-year flow. The two catch basins located within Santa Clara Avenue are also undersized for the 10-year flow. This causes just under one foot of ponding within Santa Clara Avenue, and resultant minor flooding along Tustin Avenue toward the south.

Flooding in the intersection of 17th Street and Tustin Avenue is caused by the two deficient catch basins and laterals located along 17th on the west and east side of Tustin Avenue. The 36-in RCP downstream of these catch basins also has inadequate capacity to convey the 10-year flow. Ponding caused by these issues mostly stays within the intersection and adjacent vacant parcel to the northeast.

There is approximately one foot of flooding within Catalina Avenue caused by an undersized catch basin and lateral located at the intersection of Catalina Avenue and Millwood Street. The main line that this lateral connects in to is adequately sized to contain the 10-year flow.

Wellington Avenue experiences 1-1.5 ft of flooding in the 10-year scenario from Cabrillo Park Drive to 500 ft east of Williams Street. This is due to two undersized catch basins and laterals; one located south of 16th Street along Williams Street and one located at the intersection of Williams Street and Cabrillo Park Drive. A moderate portion of the floodwaters from this area overflow onto Cabrillo Park Drive and continue to flow south.

One catch basin along Cabrillo Park Drive south of 4th Street is undersized for the 10-year scenario, causing additional flooding along the street. This flooding travels south toward 1st Street and causes issues in the commercial development south of 1st Street.

Subarea 2

Ponding issues along Tustin Avenue south of 17th Street are due to four undersized catch basins and an deficient main line along Tustin Avenue. Two catch basins at the intersection of Wellington Avenue and Tustin Avenue and the associated laterals are unable to convey the 10-year flow, causing water to flow toward the south along Tustin Avenue. The two catch basins and laterals located at the intersection of Fruit Street and Tustin Avenue are also unable to convey the 10-year flow in addition to the overflow from the catch basins at Wellington Avenue. The 27-in RCP main line south of Fruit Street is deficient as well, causing flow from the storm drain upstream to surcharge through the catch basins located along Tustin Avenue. Overflow from Tustin Avenue travels westward and causes additional ponding issues along 4th Street. When 4th Street ponds deep enough, floodwaters travel south along Cabrillo Park Drive, causing issues

10.1.1.1 Santa Fe-Tustin Model Validation

Since there are no known flooding areas within the Santa Fe- Tustin watershed, there is no data available to validate the existing model.

10.1.2 Street Deficiency

Of the nodes which remain flooded in the existing condition, some of these nodes result in street deficiencies while the magnitude of flooding in other nodes do not result in street deficiencies. Streets are defined as being deficient if the max depth at a node/street is greater than the max allowable design protection. The 2D flooding inundation extent was used in conjunction with the 1D hydraulics to determine the street deficiency.

By comparing the magnitude of the maximum depth at each node and the 2D overland flooding which remains flooded in the existing condition with the max allowable depth according to each typical street section, streets are deficient at the following node locations shown on Table 10-1Table 4-1 and

Table 10-2Table 4-2.

Table 10-1: Santa Fe-Tustin Street Deficiencies Per Max Allowable Flow (100-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
MH-480	Tustin Ave	S of Fruit Street	Arterial (120')	2.955	0.85
MH-1470	Tustin Ave	@ Fruit Street	Arterial (120')	1.639	0.85
MH-1471	Tustin Ave	S of Fruit Street	Arterial (120')	1.63	0.85
CB-170	Tustin Ave	@ 17th Street	Arterial (120')	1.032	0.85
1864	1st Street	@ Cabrillo Park Dr	Arterial (120')	0.972	0.85
CB-1993	Fruit Street	@ Wright Street	Local	2.45	0.71
MH-514	McFadden Ave	@ Mantle Lane	Arterial (100')	21.463	0.83
MH-515	McFadden Ave	@ Mantle Lane	Arterial (100')	2.502	0.83
CB-1325	Village Way	@ SR-55	Local	1.636	0.71
MH-1340	Village Way	@ SR-55	Local	1.485	0.71

Table 10-2: Santa Fe-Tustin Street Deficiencies Per Max Allowable Flow (10-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
MH-480	Tustin Ave	S of Fruit Street	Arterial (120')	0.959	0.73
CB-170	Tustin Ave	@ 17th Street	Arterial (120')	0.877	0.73
1864	1st Street	@ Cabrillo Park Dr	Arterial (120')	0.879	0.73
CB-1993	Fruit Street	@ Wright Street	Local	0.872	0.5

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
MH-514	McFadden Ave	@ Mantle Lane	Arterial (100')	4.213	0.55
MH-515	McFadden Ave	@ Mantle Lane	Arterial (100')	5.068	0.55
CB-1325	Village Way	@ SR-55	Local	1.234	0.5
MH-1340	Village Way	@ SR-55	Local	1.055	0.5

10.1.3 Known Flooding Area and Winter 2017 Storms

There are no known flooding areas within the Santa Fe Tustin watershed.

10.2 Proposed Condition

A description of the proposed improvement areas within the Santa Fe Tustin watershed are discussed below. For a compiled list of proposed improvements, see Table 10-3 and Table 10-4. Figure 10-6 and Figure 10-7 show the 10-year and 100-year proposed condition maximum depth results. Figure 10-8 and Figure 10-9 show the 10-year and 100-year proposed condition duration of inundation maps. Figure 10-10 and Figure 10-11 show the 10-year and 100-year difference (existing vs proposed) depth maps. Figure 10-12 through Figure 10-16 show the proposed facilities.

Subarea 1

Upsizing the two catch basins located at Tustin Avenue and Fairhaven Avenue and Ponderosa Street and Fairhaven Avenue prevents 10-year runoff from slowing south. The main lines and laterals are appropriately sized in this area and are able to convey the added flow from the proposed catch basins.

The catch basin at Grovemont Street and Tustin Avenue is undersized for the 10-year storm scenario. Upsizing this catch basin and adding an additional 28’ catch basin removes most of the flooding from the surface. The catch basin on the east side of Tustin Avenue south of Catalina Avenue is unable to fully capture the 10-year flow, which then continues south along Tustin Avenue. Adding one more catch basin on the east side of the street and upsizing the existing catch basin is enough to reduce most of the overflow. The lateral also needs to be upsized in order to convey the additional flow due to increased catch basin capacity.

The two catch basins located in the sump at 17th Street and Tustin Avenue are unable to drain the 10-year flow, in addition to the overflow coming from the north along Tustin Avenue. Upsizing the two catch basins at this location to 28’ and adding an additional catch basin to the west helps drain this sump and prevent excessive flooding. It is also recommended to upsize the laterals that connect the proposed catch basins at this location to the main line. Lastly, the main line to the west from the intersection of 17th Street and Tustin Avenue is unable to convey the 10-year flow, causing upstream flows to back up and spill out through catch basins. Upsizing the main line in this area fully conveys the flow, preventing this issue from occurring.

Flooding issues along Catalina can be improved by upsizing the existing catch basin at this location and adding another 28' catch basin. The lateral that connects the existing catch basin into the main line is also recommended to be upsized.

Since the flooding along Wellington Avenue is due to undersized catch basins located along Williams Street 500 ft south of 17th Street and at the intersection of Wellington Avenue and Williams Street, simply upsizing these catch basins and adding two additional catch basins is sufficient to remove one ft of ponding from the 10-year scenario. This also prevents overflow from continuing on to Cabrillo Park Drive. The existing main line is sufficient to convey the 10-year flow.

10-Year flooding in the commercial development south of 1st Street can be removed by upsizing the catch basin and main line along Cabrillo Park Drive south of 4th Street. Increasing the size of the catch basin 500-ft to the east of Cabrillo Park Drive along 1st Street provides additional benefits to the commercial area as well.

Subarea 2

The system along Tustin Avenue south of 17th Street has multiple deficiencies. The intersection at Wellington Avenue and Fruit Street have deficient catch basins. It is proposed to upsize the four catch basins on both sides of the road and add four more. The main line south of Fruit Street is unable to convey the 10-year flow, requiring a portion of storm drain to be upsized. This system not only improves the flooding along Tustin Avenue, but also along 4th Street and Cabrillo Park Drive.

10.2.1 Drainage Improvements

10.2.1.1 Santa Fe Tustin Catch Basins

Table 10-3 lists which catch basins are recommended for improvement. Details on existing and proposed catch basin sizes can be found in Appendix F.

Table 10-3 Santa Fe Tustin Proposed Upsized Catch Basins

Sub Area 1 (1 of 2)
CB-14, CB-20, CB-1306, CB-1314, CB-1784, CB-22, CB-180*, CB-1322, CB-182*, CB-1323, CB-1324, CB-179, CB-168
Sub Area 1 (2 of 2)
CB-184*, CB-1814, CB-1816, CB-183*, CB-15, CB-189*, CB-1834, CB-1337, CB-190*, CB-17, CB-16, CB-174, CB-175
Sub Area 2
CB-28, CB-181*, CB-176, CB-177, CB-185*, CB-186*, CB-25, CB-24, CB-187*, CB-188*, CB-26, CB-27

* New catch basin

10.2.1.2 Santa Fe Tustin Proposed SD Improvements

Table 10-4: Santa Fe Tustin Proposed Storm Drains

Street Name	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1 (1 of 2)				
	Link 173*	-	24	45
N Tustin Ave	SASF_TA_207-208_B_EX	18	30	133
Millwood St	Link 175*	-	24	155
Catalina Ave	SASF_TA_213-214_A_EX	24	42	151
E 20th St	GU-52*	-	24	66
E 20th St	SASF_TA_214-215_A_EX	24	36	45
Sub Area 1 (2 of 2)				
E 17th St	Link159*	36	48	442
N Golden Circle Dr	Link168	18	36	32
N Williams St	Link177*	-	24	48
N Williams St	SASF_TA_216-216.3_A_EX	24	36	30
E Wellington Ave	Link176*	-	24	41
E Wellington Ave	SASF_TA_216.5-217_A_EX	24	36	80
E Fruit St	Link182*	-	24	62
E Fruit St	SASF_TA_221-222_A_EX	24	36	32
Park Center Dr	SASF_TA_224-224.5_A_EX	24	42	44
Park Ct Pl	Link183*	-	24	84
Cabrillo Park Dr	SASF_TA_229-230_8_EX	18	30	351
E 1st St	Link167*	-	30	93
5 Fwy	SASF_TA_232-233_1_EX	42	48	382
Eastside Ave	SASF_TA_233-237_1_EX	42	48	132
Eastside Ave	SASF_TA_233-237_2_EX	42	48	191
Eastside Ave	SASF_TA_233-237_3_EX	42	48	287
Sub Area 2				
E 17th St	Link174*	-	24	71
E 17th St	Link170*	-	30	118
E 17th St	Link169*	-	24	141
E 17th St	SASF_TA_245-209_1_EX	36	48	610
N Tustin Ave	Link178*	-	24	46
N Tustin Ave	SASF_TA_245-246_B_EX	24	36	53
N Tustin Ave	Link179*	-	24	57
N Tustin Ave	SASF_TA_245-246_A_EX	24	36	50
N Tustin Ave	Link180*	-	24	48
N Tustin Ave	SASF_TA_246-247_A_EX	24	36	78
N Tustin Ave	Link181*	-	24	46
N Tustin Ave	SASF_TA_246-247_B_EX	24	36	74
N Tustin Ave	SASF_TA_247-248_1_EX	33	48	98
N Tustin Ave	SASF_TA_247-248_2_EX	33	48	1263
N Tustin Ave	SASF_TA_247-248_3_EX	4' x 2' RCB	48	154
N Tustin Ave	SASF_TA_247-248_4_EX	33	48	708
N Tustin Ave	SASF_TA_247-248_5_EX	33	48	117

* New storm drain

10.3 Cost Estimates

Table 10-5 shows the proposed storm drain cost estimate summary. For detailed cost estimates see Appendix C.

Table 10-5: Santa Fe Tustin Proposed Storm Drain Cost Estimate

Santa Fe Tustin Proposed Storm Drain Cost Estimate	
Sub Areas	**Total Project Cost**
1 (1 of 2)	$333,000
1 (2 of 2)	$1,649,000
2	$2,842,000
3	$0
Total	**$4,824,000**

11 Wintersburg Watershed Description

The Wintersburg watershed is bounded by Westminster Avenue to the north, Ward Street to the west, Mile Square Park to the south, and the Santa Ana River to the east. The watershed consists of three (3) storm drain systems; (1) Wintersburg Channel System, (2) Morningside Drain System, and (3) Fountain Valley System.

The largest storm drain system (Wintersburg Channel System), which drains 90% of the total watershed, contains the East Garden Grove Wintersburg Channel (OCFCD Facility No. C05) with a tributary area of approximately 2,230 acres. A series of storm drain systems collect flow and outlet to the Wintersburg Channel. The existing system ranges in size from 24-inches RCP to a 16'W x 10'H Reinforced Concrete Box (RCB). Runoff generally flows south and west toward the Wintersburg Channel.

The Morningside Drain System has a tributary area of approximately 90 acres (~ 4% of total watershed) and ranges from 12-ines to 50-ines before outletting into the Morningside Drain which eventually outlets to the Westminster Channel.

The Fountain Valley system has a tributary area of approximately 150 acres (~ 6% of total watershed) and ranges from 42-ines at the intersection of McFadden Avenue and Harbor Blvd to 63-ines before continuing to Fountain Valley property.

11.1 Existing Condition

The existing condition flood routing analyses was performed to identify existing street surface conveyance and storm drain capacities and to acquire a benchmark for the proposed analyses. The 10- and 100-year annual chance models were then calculated to develop a basis for the evaluation and development of potential drainage improvements.

In this study the following updates were made to the SDMP Phase 1 hydrology delineation and/or storm drain geometry. This update/revision is to further define the drainage pattern. Figure 11-1 shows the Wintersburg watershed subarea map.

Subarea 1

1. CB-83 – represents two catch basins (83 and 82). Therefore, the inflow was split equally between the two catch basins to reflect Google Earth.

Subarea 3

1. CB-110 – represents two catch basins based on Google Earth. The inflow and inlet capacity was equally split between CB-110 and CB-111.
2. CB-135 – According to the SDMP Phase 1 report the location is at the intersection of Newhope and Westminster Avenue but according to Google Earth, it is actually located on Westminster just west of A Better Way. The CB represents two catch basins (CB-135 and CB-134). Therefore, the inflow and inlet capacity was equally split between the two catch basins.

Subarea 8

1. The facility just west of Kona Avenue that flows north and confluences with the open channel that continues west, was formerly modeled as an open channel. According to OC Facilities map, this is supposed to be a 48-inch pipe, therefore the model was updated. The storm drain line on

McFadden Ave. and the 48-inch pipe that outlets to the open channel was adjusted to the NAVD 88 (+2.41) datum per the SDMP Phase 1 Study.

Subarea 9

1. The county facility C05 goes underground at the corner of Hazard and Newhope. The underground RCB that connects the channel on either side of a park was not originally modeled in the existing condition model so there was unrealistic flooding in the area. The necessary links were added to the model based on the Orange County Facilities Map. The invert elevations were generated using the slope between the upstream and downstream ends.
2. MH-1311 was changed to CB-1311 since Google Earth verifies that it is a catch basin and not a manhole. The flow for two areas was added as a constant inflow to MH-687. New hydrographs were generated for those two areas and the inflow hydrographs and inlet capacity calculations (using Bentley FlowMaster) were input to CB-1311 and the newly added CB-381. The constant inflow was removed from MH-687. Assumed a 1% slope for the lateral connecting CB-381 to CB-1311, based on the slope of the street. The hydrograph was divided equally between the two catch basins.
3. At MH-1223, two catch basins were added (CB-382 and 383) since they were not originally in the model. The hydrograph was generated since it was previously added as a constant inflow, and the constant inflow was removed. The slope of the laterals was assumed to be 0.3%, based on the slope of the street, and downstream inverts were taken from the as-builts. Bentley FlowMaster was used for the capacity calculations. The hydrograph was divided equally between the two catch basins.

Subarea 13

1. CB-49- represents 2 catch basins (49 and 50). Therefore, the inflow was equally split between the inlets

Subarea 23

1. CB-392 and link418 were added to represent an existing catch basins and storm drain line that outlets to the Wintersburg channel. The catch basins length was assumed to be 10’ (Google Earth). A lateral of 18-in RCP and slope of 10% was assumed. Since no as-builts were available, the slope was calculated using the elevation of the catch basin and outfall location. The storm drain invert at the catch basin was assumed to be approximately 4 feet below the ground elevation, based on Orange County Standard Plans.

Subarea 25

1. Updated an existing link between MH1370 and MH 1369 to be a 2-6’ x 5.5’ RCB per the OC County Facilities map rather than the 12’ x 4.5’ RCB that was in the model.
2. MH 1366 – Raised invert because the invert was below the channel invert.

Outfall Tailwater

1. All outfalls discharging to the Wintersburg Channel were set as free flowing.
2. The 10-yr downstream tailwater for the channel was taken from the East Garden Grove-Wintersburg Channel As-Built (DWG NO. C05-101-2-A) and was determined to be a depth of 7.62 ft. The 100-yr tailwater depth was assumed to be 1 ft below the top of channel to be consistent with SDMP Phase 1.

3. For OF-19, OF-2, and OF-40 the tailwater was assumed to be at the soffit elevation for both 10-year and 100-year to be consistent with SDMP Phase 1.

11.1.1 Existing Condition Results

A description of the major flooding areas within the Wintersburg watershed shown in the 10-year and 100-year existing models are discussed below. Figure 11-2 and Figure11-3 show the 10-year and 100-year existing condition maximum depth results. Figure 11-4 and Figure 11-5 show the 10-year and 100-year existing condition duration of inundation maps.

Subarea 5

In the 10-year and 100-year storm event there is flooding on Westminster Avenue and Wilowick Golf Course caused by undersized catch basins and a deficient lateral on the storm drain line that runs along Westminster Avenue. The flooding originates on Westminster and then flows south along North Susan Street and Clinton Street before entering the golf course and continuing to North Jackson Street where it causes some minor flooding.

The storm drain line along North Harbor Blvd west of the Wilowick Golf Course is deficient and causes flooding along Harbor and Missouri Lane. The flooding begins on Harbor and flows southwest through a parking lot and into the Vintage Woods Apartment Complex.

Undersized catch basins along West 1st Street causes flooding on West 1st Street as well as North Gunther Place, North Jackson Street, North laurel Street, and North Susan Street.

Subarea 8

An undersized system that runs north from McFadden Avenue to outlet into a concrete trapezoidal channel before discharging to the Wintersburg Channel causes flooding on McFadden that continues south east along South Toland Street, West Kent Avenue, and south to Lilac Avenue.

Subarea 11

Deficient catch basins at the northwest corner of Fits Intermediate School cause flooding within the residential area immediately west of the school.

Subarea 12

Deficient catch basins at the intersection of McFadden and South Flintridge Drive cause flooding along Flintridge Drive.

Subarea 15

The storm drain line that picks up flow from Silver Drive and runs west on 5th Street before discharging to the Wintersburg Channel causes flooding on Silver Drive. The flooding is caused by deficient catch basins on Silver Drive and undersized storm drain along 5th Street. The flooding originates at Silver Drive and flows south along North Mountain View Street and South Newhope Street. The deficient catch basins on that same storm drain line causes flooding on Jenkins Street which also flows south into the Gables Mobile Estates.

Subarea 24

Flooding occurs on Newhope Street and flows southwest through a residential area, along McFadden, and continuing to Euclid Street. This flooding is caused by the deficiencies on Silver Drive and 5th street (mentioned above) as well as undersized catch basins and a storm drain that conveys flow from a local reinforced concrete trapezoidal channel under South Newhope Street before continuing as an open channel and discharging to the Wintersburg Channel.

Subarea 30

Flooding occurs on the corner of Euclid and Edinger. The flooding is caused by undersized catch basins northeast of the intersection along McFadden Avenue and Newhope Street.

Subarea 32

Some of the flooding on West Kent Avenue as well as West Crystal Lane are caused by undersized catch basins and associated laterals at the intersection of South Harbor Boulevard and West Kent Avenue.

11.1.2 Street Deficiency

Of the nodes which remain flooded in the existing condition, some of these nodes result in street deficiencies while the magnitude of flooding in other nodes do not result in street deficiencies. Streets are defined as being deficient if the max depth at a node/street is greater than the max allowable design protection. The 2D flooding inundation extent was used in conjunction with the 1D hydraulics to determine the street deficiency.

By comparing the magnitude of the maximum depth at each node and the 2D overland flooding which remains flooded in the existing condition with the max allowable depth according to each typical street section, streets are deficient at the following node locations shown on Table 11-1 and

Table 11-2.

Table 11-1: Wintersburg Street Deficiencies Per Max Allowable Flow (100-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
CB-155	Silver Drive	E of Newhope St	Local	1.688	0.71
CB-155.4	5th Street	@ Jenkins Street	Arterial (100')	1.083	0.83

Table 11-2: Wintersburg Street Deficiencies Per Max Allowable Flow (10-Year)

Label	Street	Location	Street Type	1D Node Depth (ft)	Max Allowable Flow Per Criteria (ft)
CB-155.4	5th Street	@ Jenkins Street	Arterial (100')	0.704	0.55
CB-24	McFadden Ave	E of Toland Street	Arterial (100')	0.778	0.55

11.1.3 Known Flooding Area and Winter 2017 Storms

City of Santa Ana experienced significant flooding at some locations during the 2017 winter season especially the January 12, 2017 storm. The flooding locations were observed and documented by the city Maintenance crew. These flooding locations within the Greenville Banning watershed include:

W. Davit St. and Euclid St.

Video footage shows flooding along Euclid Street and Davit Street at the cul-de-sac due to the full channel. This is located immediately adjacent to the Wintersburg Channel and floods when the channel is full. Our models do not show flooding in the existing condition for either the 10-year or 100-year storm event. Since the proposed condition reduces flooding in the surrounding areas by increasing the amount of flow diverted to the channel, the proposed condition shows flooding at the cul-de-sac in the 10-year and 100-year events.

Davit St. looking towards the cul-de-sac

Euclid Street at the intersection with Davit St.

McFadden Ave. (from Harmon Street to Genoa Dr.)

This location been previously indicated by the city to be known to flood based on the SDMP Phase 1 Study.

Flintridge Dr. (between Flight Ave. and McFadden Ave.)

This location been previously indicated by the city to be known to flood based on the SDMP Phase 1 Study.

11.2 Proposed Condition

A description of the proposed improvement areas within the Wintersburg watershed are discussed below. For a compiled list of proposed improvements, see Table 11-3 and Table 11-4. Figure 11-6 and Figure 11-7 show the 10-year and 100-year proposed condition maximum depth results. Figure 11-8 and Figure 11-9 show the 10-year and 100-year proposed condition duration of inundation maps. Figure 11-10 and Figure 11-11 show the 10-year and 100-year difference (existing vs proposed) depth maps. Figure 11-12 through Figure 11-16 show the proposed facilities.

Subarea 1

The existing system on Westminster Avenue between Roxey Drive and North Susan Street causes flooding on Westminster Avenue and the Wilowick Golf Course. The flooding in this area can be drastically reduced by upsizing catch basins and associated laterals along Westminster Avenue. Additionally, a catch basin added at the intersection with Susan Street helps alleviate the flooding.

Subarea 5

The flooding along North Harbor Blvd and Missouri Lane west of the Wilowick Golf Course can be alleviated by upsizing the mainline storm drain along Harbor Boulevard. Additionally, the addition of a catch basin and associated lateral placed on the west side of Harbor Boulevard just north of 5th Street will assist in reducing the flooding.

Flooding on West 1st Street as well as North Gunther Place, North Jackson Street, North Laurel Street, and North Susan Street can be greatly reduced by upsizing the catch basins located at the intersections of each street with 1st Street.

Subarea 8

Flooding on McFadden that continues south east along South Toland Street, West Kent Avenue, and south to Lilac Avenue can be reduced by improving the storm drain line that runs north from McFadden to outlet into the concrete trapezoidal channel described above.

Subarea 11

The flooding within the residential area immediately west of the school can be lessened by upsizing the catch basins at the northwest corner of Fits Intermediate School.

Subarea 12

The flooding along Flintridge Drive can be lessened by upsizing the catch basins at the intersection of McFadden and South Flintridge Drive.

Subarea 15

Silver Drive experiences flooding due undersized catch basins on Silver Drive and undersized storm drain along 5th Street. This flooding is significantly lessened by upsizing the catch basin on Silver Drive and improving a portion of the storm drain line. These improvements will also reduce the flooding on Jenkins Street and the Gables Mobile Estates.

Subarea 18

The Flooding on Newhope Street that flows southwest through a residential area, along McFadden, and continues to Euclid Street will be reduced due to the improvements on Silver Drive and 5th Street. In addition, by upsizing the catch basins on Newhope Street and the storm drain that conveys flow from a local reinforced concrete trapezoidal channel under South Newhope Street the flooding will be further alleviated.

Subarea 30

The flooding at the intersection of Euclid Street and Edinger Avenue is eliminated by upsizing the undersized catch basins northeast of the intersection along McFadden and Newhope.

Subarea 32

Flooding on West Kent Avenue as well as West Crystal Lane are reduced by upsizing the catch basins and associated laterals at the intersection of South Harbor Boulevard and West Kent Avenue.

11.2.1 Drainage Improvements

11.2.1.1 Wintersburg Catch Basins

Table 11-3 lists which catch basins are recommended for improvement. Details on existing and proposed catch basin sizes can be found in Appendix F.

Table 11-3 Wintersburg Proposed Upsized Catch Basins

Sub Area 1
CB-82, CB-83, CB-84, CB-85, CB-385*, CB-133
Sub Area 2
CB-86
Sub Area 5
CB-75, CB-76, CB-148, CB-149, CB-150, CB-394*
Sub Area 7
CB-10, CB-13, CB-15
Sub Area 8
CB-55
Sub Area 10
CB-4
Sub Area 11
CB-53
Sub Area 12
CB-51
Sub Area 13
CB-49, CB-50
Sub Area 14
CB-45, CB-41
Sub Area 15
CB-155, CB-155.2, CB-155.4
Sub Area 17
CB-154
Sub Area 18
CB-387*, CB-390*, CB-160, CB-161
Sub Area 32
CB-161.1, CB-163

* New catch basin

11.2.1.2 Wintersburg Proposed SD Improvements

Table 11-4: Wintersburg Proposed Storm Drains

	Existing Pipe Label	Existing Size (in)	Proposed Pipe Size (in)	Length (ft)
Sub Area 1				
Westminster Ave	SAWB_106-113_A_EX	18	36	36
Westminster Ave	SAWB_106-113_B_EX	18	36	58
N Susan St	Link411*	-	36	55
Sub Area 5				
Harbor Blvd	SAWB_160-169_1_EX	30	36	308
Harbor Blvd	SAWB_158-159_B_EX	18	36	36
Harbor Blvd	SAWB_160-169_2_EX	30	42	339
Harbor Blvd	SAWB_169-190_3_EX	36	60	346
Harbor Blvd	SAWB_169-190_2_EX	36	60	346
Harbor Blvd	SAWB_169-190_1_EX	36	60	273
Harbor Blvd	SAWB_169-190_4_EX	36	72	362
Harbor Blvd	Link420*	-	24	89
Sub Area 8				
West of Kona Ave	SAWB_265-271_1_EX	36	54	123
West of Kona Ave	SAWB_271-272_1_EX (Multi_3)	48	54	501
West of Kona Ave	SAWB_272-273_1_EX	48	60	160
Sub Area 14				
S Sail St	SAWB_364-365_2_EX	33	42	138
S Sail St	SAWB_364-365_1_EX (Mulit_2)	27	42	351
Sub Area 15				
W 5th St	SAWB_412-413_2_EX	18	36	63
W 5th St	SAWB_409-413_1_EX	33	54	241
W 5th St	SAWB_409-413_2_EX	33	54	1229
W 5th St	SAWB_413-414_1_EX	36	54	198
North of W 5th St	SAWB_405-409_1_EX	6’ x 8” RCB	6’ x 2’ RCB	204
Sub Area 18				
S Newhope St	Link415*	-	36	430
S Newhope St	Link416*	-	36	52
S Newhope St	Link417*	-	36	29
S Newhope St	Link401	36	48	73
S Newhope St	Link402	36	48	62
Sub Area 32				
Harbor Blvd	SAWB_553-560_A_EX	18	42	45

* New Link

11.3 Cost Estimates

Table 11-5 shows the proposed storm drain cost estimate summary. For detailed cost estimates see Appendix C.

Table 11-5: Wintersburg Proposed Storm Drain Cost Estimate

Wintersburg Proposed Storm Drain Cost Estimate	
Sub Areas	**Total Project Cost**
1-4, 9, 16, 17, 19-21	$101,000
5, 7, 10, 15, 22, 26	$3,409,000
6, 8, 18, 31, 32	$1,156,000
11-14, 23-25, 27-30	$365,000
Total	**$5,031,000**

12 Capital Improvement Plan

12.1 Top Recommended Improvement Projects

The top recommended improvements within the entire City upon prioritization of existing deficiencies within each regional watershed are as follows:

1. Greenville-Banning subarea 18 improvements
2. Gardens subareas 18, 19 & 20 improvements
3. Delhi subarea 1 improvements
4. Gardens subarea 14 improvements
5. Delhi subareas 16, 17 & 18 improvements
6. Delhi subarea 40 improvements
7. Delhi subarea 2 improvements
8. Santa Fe Grand subarea 3 improvements
9. Wintersburg subarea 15 improvements
10. Santa Fe subarea 1 (2 of 2) improvements

The prioritization criteria that was used to organize the improvements within each regional watershed is described in the following section and spreadsheet in Appendix G.

12.2 Prioritization Evaluation Criteria

A set of evaluation criteria was developed to assist in selecting the most viable options as the preferred projects for the City of Santa Master Plan of Drainage (MPD) Phase 2. The suitability of each option was considered using five (5) evaluation criteria:

1. Downstream to Upstream Prioritization
2. Project Cost
3. Known Flooded Areas
4. Depth of Flooding

A criterion scoring matrix helps to make informed decisions. In some instances, the most deficient system may not be the highest priority based on the scoring factors. The projects will need to be evaluated as funding becomes available. Each criterion is defined below.

12.2.1 Downstream to Upstream Prioritization

The downstream to upstream prioritization criterion provides a preference to projects that are located on the downstream end of a drainage system. Projects located downstream have the potential of benefiting a greater watershed area as these systems would possibly reduce the tailwater in the tributary systems.

To accurately score systems that act as tributaries to the main stem of a system, the assigned score of the most downstream section of the tributary will be compared to the assigned score of the main stem where the junction occurs. Independent storm drains not tied to a main stem (less than two laterals) will receive a score of no more than 4. Overall, the scores were assigned using engineering judgement. Table 12-1 shows the criterion scoring.

Table 12-1: Downstream to Upstream Prioritization Scoring

D/S to U/S Prioritization	Assigned Score
Approximately 80 - 100%	1
Approximately 60 - 80%	2
Approximately 40 - 60%	3
Approximately 20 - 40%	4
Approximately < 20%	5

12.2.2 Project Cost

The project improvement criterion accounts for the estimated proposed drainage improvements cost of each project. Projects with the lowest improvement costs were ranked “5,” and projects with the highest improvement costs were ranked “1.” Table 12-2 shows the criterion ranking.

Table 12-2: Project Cost Prioritization Scoring

Cost of Operations and Maintenance	Score
$2,000,000+	1
$1,000,000 – $2,000,000	2
$750,000 – $999,999	3
$500,000 – $749,999	4
$0 – $499,000	5

12.2.3 Known Flooded Areas

The known flooded areas criterion accounts for the projects potential to improve flooding in areas that have been documented by the city and residents. Projects with known flooded areas were ranked “5,” and projects with no known flooded areas were ranked “1.” Table 12-3 shows the criterion scoring.

Table 12-3: Known Flooded Areas Prioritization Scoring

Description	Score
Project does not contain known flooded areas	0
Project contains known flooded areas	5

12.2.4 Depth of Flooding

The depth of flooding criterion accounts for the projects with the most severe flooding depth based on the 100-year existing condition model results. Projects with less than 0.5 feet of flooding were ranked “1,” and projects with greater than 1 foot of flooding were ranked “5.” For projects located on multiple streets, the most severe flooding depth was used for the ranking. Table 12-4 shows the criterion scoring.

Table 12-4: Depth of Flooding Prioritization Scoring

Description	Score
Flooding Depths less than 0.5 feet	1
Flooding Depths between 0.5 – 1.0 feet	3
Flooding Depths greater than 1.0 feet	5

12.3 Criteria Weighting Summaries

The five screening criteria were given the weights corresponding to the relative importance of each criterion as judged by the project team. The weights for the five criteria, which add up to 100, are summarized in Table 12-5.

Once each project was scored on all five criteria, the final project ranking would be determined by a weighting system that gives priority to some criteria over others. The weighting system, shown below, was developed to further prioritize the criteria and allow for specific criteria to hold more significance in the final rank. The assigned weight is multiplied by the assigned score and each criteria is added to achieve the final rank.

Table 12-5: Evaluation Criteria Weighting

Criteria	Weight
Downstream to Upstream Prioritization	30
Project Cost	30
Known Flooded Areas	20
Depth of Flooding	20
Total	**100**

CITY OF SANTA ANA

STORM DRAIN MASTER PLAN

PHASE 2

TECHNICAL APPENDIX

TECHNICAL APPENDIX A

Existing Condition Hydrology

(Included in CD only)

TECHNICAL APPENDIX B

GIS DATA

(Included in CD only)

TECHNICAL APPENDIX C

Cost Estimates

Master Plan of Storm Drainage for the City of Santa Ana

COST ESTIMATE

Proposed Pipe Size	Unit Price	Remove
18	$140	$21.00
24	$165	$24.75
30	$180	$27.00
33	$220	$33.00
36	$250	$37.50
42	$275	$41.25
48	$290	$43.50
54	$300	$45.00
60	$365	$54.75
66	$395	$59.25
72	$425	$63.75
78	$460	$69.00
84	$490	$73.50
90	$515	$77.25
96	$535	$80.25
102	$1,500	$225.00
108	$1,600	$240.00
114	$1,700	$255.00
120	$1,800	$270.00
126	$1,900	$285.00
132	$2,000	$300.00
138	$2,100	$315.00
144	$2,200	$330.00
150	$2,300	$345.00
156	$2,400	$360.00
162	$2,500	$375.00
168	$2,600	$390.00
174	$2,700	$405.00
180	$2,800	$420.00

DELHI COST ESTIMATES

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 1
Nodes 109 - 159
Street: Washington Ave, Main St., Bush St., Spurgeon St., Santa Ana Blvd

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP	FT	95	$165	$15,675
2	Install 36" RCP	FT	82	$250	$20,500
3	Install 48" RCP	FT	470	$290	$136,300
4	Install 54" RCP	FT	3314	$300	$994,200
5	Manhole	EA	12	$4,700	$56,400
6	Catch Basin	EA	7	$5,000	$35,000
7	Junction Structure	EA	7	$2,000	$14,000
8	Utility Relocation Allowance	LS	1	$251,300	$251,300
9	Remove 12" RCP	FT	57	$21.00	$1,197
10	Remove 15" RCP	FT	228	$21	$4,788
11	Remove 18" RCP	FT	667	$21	$14,007
12	Remove 21" RCP	FT	329	$24.75	$8,143
13	Remove 27" RCP	FT	746	$27.00	$20,142
14	Remove 30" RCP	FT	1292	$27.00	$34,884
15	Remove 33" RCP	FT	642	$33.00	$21,186
16	Traffic Control	LS	1	$40,900	$40,900
17	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
18	Mobilization (10%)	LS	1	$165,800	$165,800
19	Miscellaneous Items (10%)	LS	1	$182,400	$182,400
SUBTOTAL (CONSTRUCTION)					**$2,006,147**
20	Engineering and Design (8%)	LS	1	$160,500	$160,500
21	Surveying (1%)	LS	1	$20,100	$20,100
22	Construction Management (6%)	LS	1	$120,400	$120,400
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$301,000
SUBTOTAL COST					$2,307,147
CONTINGENCY				20%	$461,429
TOTAL PROJECT					**$2,769,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 2
Nodes 118 - 159
Street: Penn Way, W. Santiago St.. Washington Ave., Santa Ana Blvd

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	952	$250	$238,000
2	Install 48" RCP	FT	1295	$290	$375,550
3	Install 54" RCP	FT	2256	$300	$676,800
4	Manhole	EA	15	$4,700	$70,500
5	Catch Basin	EA	9	$5,000	$45,000
6	Junction Structure	EA	9	$2,000	$18,000
7	Utility Relocation Allowance	LS	1	$284,800	$284,800
8	Remove 24" RCP	FT	952	$25	$23,562
9	Remove 27" RCP	FT	3551	$27.00	$95,877
10	Traffic Control	LS	1	$46,300	$46,300
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
12	Mobilization (10%)	LS	1	$188,000	$188,000
13	Miscellaneous Items (10%)	LS	1	$206,800	$206,800
	SUBTOTAL (CONSTRUCTION)				**$2,274,189**
14	Engineering and Design (8%)	LS	1	$182,000	$182,000
15	Surveying (1%)	LS	1	$22,800	$22,800
16	Construction Management (6%)	LS	1	$136,500	$136,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$341,300
	SUBTOTAL COST				$2,615,489
	CONTINGENCY			20%	$523,098
	TOTAL PROJECT				**$3,139,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi

Total Cost - SubAreas 1 - 3

SubArea	Total Project Cost
1	$2,769,000
2	$3,139,000
3	$0
Total	**$5,908,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 4
Nodes 164 - 166
Street: French St, E 4th St

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 60" RCP	FT	641	$365	$233,965
2	Manhole	EA	2	$4,700	$9,400
3	Catch Basin	EA	1	$5,000	$5,000
4	Junction Structure	EA	1	$2,000	$2,000
5	Utility Relocation Allowance	LS	1	$50,100	$50,100
6	Remove 39" RCP	FT	641	$41	$26,441
7	Traffic Control	LS	1	$8,400	$8,400
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$34,100	$34,100
10	Miscellaneous Items (10%)	LS	1	$37,500	$37,500
	SUBTOTAL (CONSTRUCTION)				**$411,906**
11	Engineering and Design (8%)	LS	1	$33,000	$33,000
12	Surveying (1%)	LS	1	$4,200	$4,200
13	Construction Management (6%)	LS	1	$24,800	$24,800
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$62,000
	SUBTOTAL COST				$473,906
	CONTINGENCY			20%	$94,781
	TOTAL PROJECT				**$569,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 5
Nodes 166 - 169
Street: French St, E 4th St, 3rd St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 60" RCP	FT	366	$365	$133,590
2	Manhole	EA	1	$4,700	$4,700
3	Catch Basin	EA	1	$5,000	$5,000
4	Junction Structure	EA	1	$2,000	$2,000
5	Utility Relocation Allowance	LS	1	$29,100	$29,100
6	Remove 39" RCP	FT	366	$41	$15,098
7	Traffic Control	LS	1	$4,900	$4,900
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$20,000	$20,000
10	Miscellaneous Items (10%)	LS	1	$22,000	$22,000
	SUBTOTAL (CONSTRUCTION)				**$241,388**
11	Engineering and Design (8%)	LS	1	$19,400	$19,400
12	Surveying (1%)	LS	1	$2,500	$2,500
13	Construction Management (6%)	LS	1	$14,500	$14,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$36,400
	SUBTOTAL COST				$277,788
	CONTINGENCY			20%	$55,558
	TOTAL PROJECT				**$333,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 7
Nodes 169 - 187
Street: French St, 1st St

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 60" RCP	FT	982	$365	$358,430
2	Manhole	EA	3	$4,700	$14,100
3	Catch Basin	EA	1	$5,000	$5,000
4	Junction Structure	EA	1	$2,000	$2,000
5	Utility Relocation Allowance	LS	1	$76,000	$76,000
6	Remove 39" RCP	FT	982	$41	$40,508
7	Traffic Control	LS	1	$12,700	$12,700
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$51,400	$51,400
10	Miscellaneous Items (10%)	LS	1	$56,600	$56,600
	SUBTOTAL (CONSTRUCTION)				**$621,738**
11	Engineering and Design (8%)	LS	1	$49,800	$49,800
12	Surveying (1%)	LS	1	$6,300	$6,300
13	Construction Management (6%)	LS	1	$37,400	$37,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$93,500
	SUBTOTAL COST				$715,238
	CONTINGENCY			20%	$143,048
	TOTAL PROJECT				**$858,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi, SUBAREA 9
Nodes 190 - 203
Street: Hathaway St., E. Walnut St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP	FT	93	$275	$25,575
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$5,200	$5,200
6	Remove 18" RCP	FT	93	$21	$1,953
7	Traffic Control	LS	1	$900	$900
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$3,900	$3,900
10	Miscellaneous Items (10%)	LS	1	$4,300	$4,300
	SUBTOTAL (CONSTRUCTION)				**$46,828**
11	Engineering and Design (8%)	LS	1	$3,800	$3,800
12	Surveying (1%)	LS	1	$500	$500
13	Construction Management (6%)	LS	1	$2,900	$2,900
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$7,200
	SUBTOTAL COST				$54,028
	CONTINGENCY			20%	$10,806
	TOTAL PROJECT				**$65,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 10
Nodes 203 - 209
Street: Maple St., E. Walnut St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 60" RCP	FT	336	$365	$122,640
2	Install Double 60" RCP	FT	758	$730	$553,340
3	Manhole	EA	3	$4,700	$14,100
4	Catch Basin	EA	2	$5,000	$10,000
5	Junction Structure	EA	2	$2,000	$4,000
6	Utility Relocation Allowance	LS	1	$140,900	$140,900
7	Remove 39" RCP	FT	336	$41	$13,860
8	Remove 48" RCP	FT	758	$44	$32,973
9	Traffic Control	LS	1	$22,600	$22,600
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$92,000	$92,000
12	Miscellaneous Items (10%)	LS	1	$101,200	$101,200
SUBTOTAL (CONSTRUCTION)					**$1,112,613**
13	Engineering and Design (8%)	LS	1	$89,100	$89,100
14	Surveying (1%)	LS	1	$11,200	$11,200
15	Construction Management (6%)	LS	1	$66,800	$66,800
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$167,100
SUBTOTAL COST					$1,279,713
CONTINGENCY				20%	$255,943
TOTAL PROJECT					**$1,536,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 11
Nodes 209 - 213
Street: E Myrtle St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	861	$290	$249,690
2	Install 24" RCP	FT	392	$165	$64,680
3	Install Double 18" RCP	FT	169	$280	$47,320
4	Manhole	EA	4	$4,700	$18,800
5	Catch Basin	EA	2	$5,000	$10,000
6	Junction Structure	EA	2	$2,000	$4,000
7	Utility Relocation Allowance	LS	1	$78,900	$78,900
8	Remove 24" RCP	FT	1030	$25	$25,493
9	Traffic Control	LS	1	$12,600	$12,600
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$51,700	$51,700
12	Miscellaneous Items (10%)	LS	1	$56,900	$56,900
	SUBTOTAL (CONSTRUCTION)				**$625,083**
13	Engineering and Design (8%)	LS	1	$50,100	$50,100
14	Surveying (1%)	LS	1	$6,300	$6,300
15	Construction Management (6%)	LS	1	$37,600	$37,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$94,000
	SUBTOTAL COST				$719,083
	CONTINGENCY			20%	$143,817
	TOTAL PROJECT				**$863,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi

Total Cost - SubAreas 4 - 11

SubArea	Total Project Cost
4	$569,000
5	$333,000
6	$0
7	$858,000
8	$0
9	$65,000
10	$1,536,000
11	$863,000
Total	**$4,224,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 12
Nodes 209 - 230
Street: S Maple, E McFadden Ave.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	90	$250	$22,500
2	Install 48" RCP	FT	115	$290	$33,350
3	Install Double 60" RCP	FT	3261	$730	$2,380,530
4	Install 8'x3' RCB	FT	107	$425	$45,475
5	Install 8'x4' RCB	FT	2097	$460	$964,620
6	Manhole	EA	18	$4,700	$84,600
7	Catch Basin	EA	11	$5,000	$55,000
8	Junction Structure	EA	11	$2,000	$22,000
9	Utility Relocation Allowance	LS	1	$721,700	$721,700
10	Remove 18" RCP	FT	312	$21	$6,552
11	Remove 36" RCP	FT	928	$37.50	$34,800
12	Remove 42" RCP	FT	1169	$41.25	$48,221
13	Remove 48" RCP	FT	3179	$43.50	$138,287
14	Remove 51" RCP	FT	82	$45.00	$3,690
15	Traffic Control	LS	1	$115,000	$115,000
16	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
17	Mobilization (10%)	LS	1	$468,200	$468,200
18	Miscellaneous Items (10%)	LS	1	$515,000	$515,000
SUBTOTAL (CONSTRUCTION)					**$5,664,525**
19	Engineering and Design (8%)	LS	1	$453,200	$453,200
20	Surveying (1%)	LS	1	$56,700	$56,700
21	Construction Management (6%)	LS	1	$339,900	$339,900
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$849,800
SUBTOTAL COST					$6,514,325
CONTINGENCY				20%	$1,302,865
TOTAL PROJECT					**$7,817,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 13
Nodes 230 - 246
Street: S Maple St. from E McFadden Ave. to Hobart St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	388	$290	$112,520
2	Install Double 60" RCP	FT	1282	$730	$935,860
3	Manhole	EA	5	$4,700	$23,500
4	Catch Basin	EA	3	$5,000	$15,000
5	Junction Structure	EA	3	$2,000	$6,000
6	Utility Relocation Allowance	LS	1	$218,600	$218,600
7	Remove 24" RCP	FT	388	$24.75	$9,603
8	Remove 51" RCP	FT	1282	$45	$57,690
9	Traffic Control	LS	1	$34,900	$34,900
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$141,900	$141,900
12	Miscellaneous Items (10%)	LS	1	$156,100	$156,100
	SUBTOTAL (CONSTRUCTION)				**$1,716,673**
13	Engineering and Design (8%)	LS	1	$137,400	$137,400
14	Surveying (1%)	LS	1	$17,200	$17,200
15	Construction Management (6%)	LS	1	$103,100	$103,100
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$257,700
	SUBTOTAL COST				$1,974,373
	CONTINGENCY			20%	$394,875
	TOTAL PROJECT				**$2,369,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 14
Nodes 240 - 246
Street: Hobat St., S Main St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 8'x2.5' RCB	FT	450	$395	$177,750
2	Install 8'x3.5' RCB	FT	397	$460	$182,620
3	Install 8'x4' RCB	FT	489	$460	$224,940
4	Manhole	EA	4	$4,700	$18,800
5	Catch Basin	EA	2	$5,000	$10,000
6	Junction Structure	EA	2	$2,000	$4,000
7	Utility Relocation Allowance	LS	1	$123,700	$123,700
8	Remove 24" RCP	FT	450	$25	$11,138
9	Remove 27" RCP	FT	397	$27	$10,719
10	Remove 36" RCP	FT	489	$37.50	$18,338
11	Traffic Control	LS	1	$19,800	$19,800
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
13	Mobilization (10%)	LS	1	$80,700	$80,700
14	Miscellaneous Items (10%)	LS	1	$88,800	$88,800
SUBTOTAL (CONSTRUCTION)					**$976,304**
15	Engineering and Design (8%)	LS	1	$78,200	$78,200
16	Surveying (1%)	LS	1	$9,800	$9,800
17	Construction Management (6%)	LS	1	$58,600	$58,600
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$146,600
SUBTOTAL COST					$1,122,904
CONTINGENCY				20%	$224,581
TOTAL PROJECT					**$1,347,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 15
Nodes 246 - 252
Street: S Maple St. from E McFadden Ave. to Hobart St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	272	$1,900	$516,800
2	Install 39" RCP	FT	299	$275	$82,225
3	Install Double 60" RCP	FT	1078	$730	$786,940
4	Manhole	EA	5	$4,700	$23,500
5	Catch Basin	EA	3	$5,000	$15,000
6	Junction Structure	EA	3	$2,000	$6,000
7	Utility Relocation Allowance	LS	1	$286,100	$286,100
8	Remove 24" RCP	FT	272	$25	$6,732
9	Remove 39" RCP	FT	299	$41	$12,334
10	Remove 51" RCP	FT	1078	$45	$48,510
11	Traffic Control	LS	1	$44,400	$44,400
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
13	Mobilization (10%)	LS	1	$183,400	$183,400
14	Miscellaneous Items (10%)	LS	1	$201,700	$201,700
SUBTOTAL (CONSTRUCTION)					**$2,218,641**
15	Engineering and Design (8%)	LS	1	$177,500	$177,500
16	Surveying (1%)	LS	1	$22,200	$22,200
17	Construction Management (6%)	LS	1	$133,200	$133,200
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$332,900
SUBTOTAL COST					$2,551,541
CONTINGENCY				20%	$510,308
TOTAL PROJECT					**$3,062,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi

Total Cost - SubAreas 12 - 15

SubArea	Total Project Cost
12	$7,817,000
13	$2,369,000
14	$1,347,000
15	$3,062,000
Total	**$14,595,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 16
Nodes 252 - 257
Street: Roussille St. from Edinger to E St. Andrew Pl

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	41	$290	$11,890
2	Install 10'x6' RCB	FT	1634	$1,600	$2,614,400
3	Manhole	EA	5	$4,700	$23,500
4	Catch Basin	EA	3	$5,000	$15,000
5	Junction Structure	EA	3	$2,000	$6,000
6	Utility Relocation Allowance	LS	1	$534,200	$534,200
7	Remove 51" RCP	FT	1634	$45	$73,530
8	Remove 12" RCP	FT	41	$21	$861
9	Traffic Control	LS	1	$82,400	$82,400
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$336,700	$336,700
12	Miscellaneous Items (10%)	LS	1	$370,400	$370,400
	SUBTOTAL (CONSTRUCTION)				**$4,073,881**
13	Engineering and Design (8%)	LS	1	$326,000	$326,000
14	Surveying (1%)	LS	1	$40,800	$40,800
15	Construction Management (6%)	LS	1	$244,500	$244,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$611,300
	SUBTOTAL COST				$4,685,181
	CONTINGENCY			20%	$937,036
	TOTAL PROJECT				**$5,622,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 17
Nodes 257 - 262
Street: Roussille St. from E St. Andrew Pl to E St. Gertrude Pl

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	340	$250	$85,000
2	Install 10'x6' RCB	FT	990	$1,600	$1,584,000
3	Manhole	EA	4	$4,700	$18,800
4	Catch Basin	EA	2	$5,000	$10,000
5	Junction Structure	EA	2	$2,000	$4,000
6	Utility Relocation Allowance	LS	1	$340,400	$340,400
7	Remove 51" RCP	FT	990	$45	$44,550
8	Remove 12" RCP	FT	340	$21	$7,140
9	Traffic Control	LS	1	$52,700	$52,700
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$215,200	$215,200
12	Miscellaneous Items (10%)	LS	1	$236,700	$236,700
	SUBTOTAL (CONSTRUCTION)				**$2,603,490**
13	Engineering and Design (8%)	LS	1	$208,300	$208,300
14	Surveying (1%)	LS	1	$26,100	$26,100
15	Construction Management (6%)	LS	1	$156,300	$156,300
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$390,700
	SUBTOTAL COST				$2,994,190
	CONTINGENCY			20%	$598,838
	TOTAL PROJECT				**$3,593,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 18
Nodes 262 - 265
Street: Roussille St. from E St. Gertrude Pl to E Anahurst Pl

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 10'x6' RCB	FT	681	$1,600	$1,089,600
2	Install 48" RCP	FT	109	$290	$31,610
3	Manhole	EA	2	$4,700	$9,400
4	Catch Basin	EA	1	$5,000	$5,000
5	Junction Structure	EA	1	$2,000	$2,000
6	Utility Relocation Allowance	LS	1	$227,600	$227,600
7	Remove 12" RCP	FT	109	$21	$2,289
8	Remove 51" RCP	FT	681	$45	$30,645
9	Traffic Control	LS	1	$35,100	$35,100
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$143,900	$143,900
12	Miscellaneous Items (10%)	LS	1	$158,300	$158,300
	SUBTOTAL (CONSTRUCTION)				**$1,740,444**
13	Engineering and Design (8%)	LS	1	$139,300	$139,300
14	Surveying (1%)	LS	1	$17,500	$17,500
15	Construction Management (6%)	LS	1	$104,500	$104,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$261,300
	SUBTOTAL COST				$2,001,744
	CONTINGENCY			20%	$400,349
	TOTAL PROJECT				**$2,402,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 19
Nodes 265 - 285
Street: Roussille St. from E Anahurst Pl to Warner Ave, Standard Ave

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 10'x6' RCB	FT	633	$1,600	$1,012,800
2	Install 36" RCP	FT	238	$250	$59,500
3	Install 60" RCP	FT	2172	$365	$792,780
4	Install 60" RCP*	FT	1356	$365	$494,940
5	Manhole	EA	10	$4,700	$47,000
6	Catch Basin	EA	6	$5,000	$30,000
7	Junction Structure	EA	6	$2,000	$12,000
8	Utility Relocation Allowance	LS	1	$489,900	$489,900
9	Remove 18" RCP	FT	40	$21	$840
10	Remove 24" RCP	FT	152	$25	$3,762
11	Remove 27" RCP	FT	2218	$27	$59,886
12	Remove 51" RCP	FT	633	$45	$28,485
13	Traffic Control	LS	1	$76,200	$76,200
14	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
15	Mobilization (10%)	LS	1	$311,400	$311,400
16	Miscellaneous Items (10%)	LS	1	$342,500	$342,500
SUBTOTAL (CONSTRUCTION)					**$3,766,993**
17	Engineering and Design (8%)	LS	1	$301,400	$301,400
18	Surveying (1%)	LS	1	$37,700	$37,700
19	Construction Management (6%)	LS	1	$226,100	$226,100
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$565,200
SUBTOTAL COST					$4,332,193
CONTINGENCY				20%	$866,439
TOTAL PROJECT					**$5,199,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi

Total Cost - SubAreas 16 - 19

SubArea	Total Project Cost
16	$5,622,000
17	$3,593,000
18	$2,402,000
19	$5,199,000
Total	**$16,816,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 20
Nodes 289 - 307
Street: Broadway, Civic Center Dr., Ross St

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	971	$250	$242,750
2	Install 6'x2' RCB	FT	978	$290	$283,620
3	Install 6'x3' RCB	FT	379	$365	$138,335
4	Manhole	EA	7	$4,700	$32,900
5	Catch Basin	EA	4	$5,000	$20,000
6	Junction Structure	EA	4	$2,000	$8,000
7	Utility Relocation Allowance	LS	1	$145,200	$145,200
8	Remove 18" RCP	FT	134	$21	$2,814
9	Remove 21" RCP	FT	837	$25	$20,716
10	Remove 24" RCP	FT	1357	$25	$33,586
11	Traffic Control	LS	1	$23,500	$23,500
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
13	Mobilization (10%)	LS	1	$95,700	$95,700
14	Miscellaneous Items (10%)	LS	1	$105,300	$105,300
	SUBTOTAL (CONSTRUCTION)				**$1,157,421**
15	Engineering and Design (8%)	LS	1	$92,600	$92,600
16	Surveying (1%)	LS	1	$11,600	$11,600
17	Construction Management (6%)	LS	1	$69,500	$69,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$173,700
	SUBTOTAL COST				$1,331,121
	CONTINGENCY			20%	$266,224
	TOTAL PROJECT				**$1,597,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi, SUBAREA 21
Nodes 296 - 320
Street: 3rd St

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 6'x3' RCB	FT	294	$365	$107,310
2	Install 10'X4' RCB	FT	268	$515	$138,020
3	Install 30" RCP	FT	28	$180	$5,040
4	Install 18" RCP	FT	50	$140	$7,000
5	Install Double 36" RCP	FT	1498	$500	$749,000
4	Manhole	EA	7	$4,700	$32,900
5	Catch Basin	EA	4	$5,000	$20,000
6	Junction Structure	EA	4	$2,000	$8,000
7	Utility Relocation Allowance	LS	1	$213,500	$213,500
8	Remove 21" RCP	FT	649	$25	$16,063
9	Remove 24" RCP	FT	1171	$25	$28,982
10	Remove 33" RCP	FT	268	$33	$8,844
11	Traffic Control	LS	1	$33,700	$33,700
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
13	Mobilization (10%)	LS	1	$137,400	$137,400
14	Miscellaneous Items (10%)	LS	1	$151,100	$151,100
	SUBTOTAL (CONSTRUCTION)				**$1,661,859**
15	Engineering and Design (8%)	LS	1	$133,000	$133,000
16	Surveying (1%)	LS	1	$16,700	$16,700
17	Construction Management (6%)	LS	1	$99,800	$99,800
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$249,500
	SUBTOTAL COST				$1,911,359
	CONTINGENCY			20%	$382,272
	TOTAL PROJECT				**$2,294,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 22
Nodes 312 - 326
Street: N Flower St., W. Walnut St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	1280	$290	$371,200
2	Install 54" RCP	FT	870	$300	$261,000
3	Install 66" RCP	FT	384	$395	$151,680
4	Install 10'x4' RCB	FT	1384	$515	$712,760
5	Manhole	EA	13	$4,700	$61,100
6	Catch Basin	EA	7	$5,000	$35,000
7	Junction Structure	EA	7	$2,000	$14,000
8	Utility Relocation Allowance	LS	1	$321,400	$321,400
9	Remove 36" RCP	FT	824	$38	$30,900
10	Remove 33" RCP	FT	3094	$33	$102,102
11	Traffic Control	LS	1	$52,200	$52,200
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
13	Mobilization (10%)	LS	1	$211,900	$211,900
14	Miscellaneous Items (10%)	LS	1	$233,100	$233,100
	SUBTOTAL (CONSTRUCTION)				**$2,563,342**
15	Engineering and Design (8%)	LS	1	$205,100	$205,100
16	Surveying (1%)	LS	1	$25,700	$25,700
17	Construction Management (6%)	LS	1	$153,900	$153,900
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$384,700
	SUBTOTAL COST				$2,948,042
	CONTINGENCY			20%	$589,608
	TOTAL PROJECT				**$3,538,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi, SUBAREA 23
Nodes 330 - 348
Street:Shelton St., McFadden Ave.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	625	$250	$156,250
2	Install 42" RCP	FT	388	$275	$106,700
3	Install 48" RCP	FT	3093	$290	$896,970
4	Install 10'x6' RCB	FT	2791	$1,600	$4,465,600
5	Manhole	EA	22	$4,700	$103,400
6	Catch Basin	EA	13	$5,000	$65,000
7	Junction Structure	EA	13	$2,000	$26,000
8	Utility Relocation Allowance	LS	1	$1,164,000	$1,164,000
9	Remove 27" RCP	FT	2384	$27	$64,368
10	Remove 30" RCP	FT	1722	$27	$46,494
11	Remove 33" RCP	FT	1293	$33	$42,669
12	Remove 42" RCP	FT	1498	$41	$61,793
13	Traffic Control	LS	1	$181,100	$181,100
14	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
15	Mobilization (10%)	LS	1	$738,600	$738,600
16	Miscellaneous Items (10%)	LS	1	$812,400	$812,400
			SUBTOTAL (CONSTRUCTION)		**$8,936,344**
17	Engineering and Design (8%)	LS	1	$715,000	$715,000
18	Surveying (1%)	LS	1	$89,400	$89,400
19	Construction Management (6%)	LS	1	$536,200	$536,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$1,340,600
			SUBTOTAL COST		$10,276,944
			CONTINGENCY	20%	$2,055,389
			TOTAL PROJECT		**$12,332,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi

Total Cost - SubAreas 20 - 23

SubArea	Total Project Cost
20	$1,597,000
21	$2,294,000
22	$3,538,000
23	$12,332,000
Total	**$19,761,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 24
Nodes 342 - 348
Street: S Rosewood Ave, W Bishop St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 21" RCP*	FT	92	$250	$23,000
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$4,600	$4,600
6	Traffic Control	LS	1	$700	$700
7	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
8	Mobilization (10%)	LS	1	$3,400	$3,400
9	Miscellaneous Items (10%)	LS	1	$3,700	$3,700
	SUBTOTAL (CONSTRUCTION)				**$40,400**
10	Engineering and Design (8%)	LS	1	$3,300	$3,300
11	Surveying (1%)	LS	1	$500	$500
12	Construction Management (6%)	LS	1	$2,500	$2,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$6,300
	SUBTOTAL COST				$46,700
	CONTINGENCY			20%	$9,340
	TOTAL PROJECT				**$56,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 25
Nodes 350 - 352
Street: Richland Ave

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 42" RCP	FT	269	$275	$73,975
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$14,800	$14,800
6	Remove 18" RCP	FT	269	$21	$5,649
7	Traffic Control	LS	1	$2,400	$2,400
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$10,200	$10,200
10	Miscellaneous Items (10%)	LS	1	$11,300	$11,300
	SUBTOTAL (CONSTRUCTION)				**$123,324**
1	Engineering and Design (8%)	LS	1	$9,900	$9,900
2	Surveying (1%)	LS	1	$1,300	$1,300
3	Construction Management (6%)	LS	1	$7,400	$7,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$18,600
	SUBTOTAL COST				$141,924
	CONTINGENCY			20%	$28,385
	TOTAL PROJECT				**$170,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 26
Nodes 348 - 380
Street: Shelton St., McFadden Ave., Cubbon St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 72" RCP	FT	1384	$425	$588,200.00
2	Install 10'x6' RCB	FT	2154	$1,600	$3,446,400.00
3	Manhole	EA	11	$4,700	$51,700.00
4	Catch Basin	EA	7	$5,000	$35,000.00
5	Junction Structure	EA	7	$2,000	$14,000.00
6	Utility Relocation Allowance	LS	1	$827,100	$827,100.00
7	Remove 36" RCP	FT	1384	$38	$51,900.00
8	Remove 45" RCP	FT	1768	$44	$76,908.00
9	Remove 48" RCP	FT	386	$44	$16,791.00
10	Traffic Control	LS	1	$128,500	$128,500.00
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
12	Mobilization (10%)	LS	1	$524,200	$524,200.00
13	Miscellaneous Items (10%)	LS	1	$576,600	$576,600.00
	SUBTOTAL (CONSTRUCTION)				**$6,342,299**
14	Engineering and Design (8%)	LS	1	$507,400	$507,400
15	Surveying (1%)	LS	1	$63,500	$63,500
16	Construction Management (6%)	LS	1	$380,600	$380,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$951,500
	SUBTOTAL COST				$7,293,799
	CONTINGENCY			20%	$1,458,760
	TOTAL PROJECT				**$8,753,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 27
Nodes 361 - 380
Street: Flower St., Cubbon St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	70	$250	$17,500.00
2	Install 48" RCP	FT	168	$290	$48,720.00
3	Install 54" RCP	FT	1655	$300	$496,500.00
4	Install 60" RCP	FT	918	$365	$335,070.00
5	Install 72" RCP	FT	70	$425	$29,750.00
6	Install 10'x6' RCB	FT	333	$1,600	$532,800.00
7	Manhole	EA	10	$4,700	$47,000.00
8	Catch Basin	EA	5	$5,000	$25,000.00
9	Junction Structure	EA	5	$2,000	$10,000.00
10	Utility Relocation Allowance	LS	1	$308,500	$308,500.00
11	Remove 18" RCP	FT	249	$21	$5,229.00
12	Remove 24" RCP	FT	378	$25	$9,355.50
13	Remove 27" RCP	FT	387	$27	$10,449.00
14	Remove 30" RCP	FT	809	$27	$21,843.00
15	Remove 33" RCP	FT	1251	$33	$41,283.00
16	Remove 36" RCP	FT	70	$38	$2,625.00
17	Remove 12" RCP	FT	70	$21	$1,470.00
18	Traffic Control	LS	1	$49,100	$49,100.00
19	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
20	Mobilization (10%)	LS	1	$199,800	$199,800.00
21	Miscellaneous Items (10%)	LS	1	$219,700	$219,700.00
	SUBTOTAL (CONSTRUCTION)				**$2,416,695**
22	Engineering and Design (8%)	LS	1	$193,400	$193,400
23	Surveying (1%)	LS	1	$24,200	$24,200
24	Construction Management (6%)	LS	1	$145,100	$145,100
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$362,700
	SUBTOTAL COST				$2,779,395
	CONTINGENCY			20%	$555,879
	TOTAL PROJECT				**$3,335,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi

Total Cost - SubAreas 24 - 27

SubArea	Total Project Cost
24	$56,000
25	$170,000
26	$8,753,000
27	$3,335,000
Total	**$12,314,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 28
Nodes 381 - 390
Street: Towner St., W Wilson Ave.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 54" RCP	FT	348	$300	$104,400.00
2	Install 48" RCP	FT	1377	$290	$399,330.00
3	Install 14'x6' RCB	FT	1291	$1,900	$2,452,900.00
4	Manhole	EA	10	$4,700	$47,000.00
5	Catch Basin	EA	6	$5,000	$30,000.00
6	Junction Structure	EA	6	$2,000	$12,000.00
7	Utility Relocation Allowance	LS	1	$609,200	$609,200.00
8	Remove 30" RCP	FT	1725	$27	$46,575.00
9	Remove 54" RCP	FT	1291	$45	$58,095.00
10	Traffic Control	LS	1	$94,600	$94,600.00
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
12	Mobilization (10%)	LS	1	$386,000	$386,000.00
13	Miscellaneous Items (10%)	LS	1	$424,600	$424,600.00
	SUBTOTAL (CONSTRUCTION)				**$4,669,700**
14	Engineering and Design (8%)	LS	1	$373,600	$373,600
15	Surveying (1%)	LS	1	$46,700	$46,700
16	Construction Management (6%)	LS	1	$280,200	$280,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$700,500
	SUBTOTAL COST				$5,370,200
	CONTINGENCY			20%	$1,074,040
	TOTAL PROJECT				**$6,444,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 29
Nodes 390 - 430
Street: Towner St., W Edinger Ave.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	680	$250	$170,000.00
2	Install 14'x6' RCB	FT	2262	$1,900	$4,297,800.00
3	Manhole	EA	9	$4,700	$42,300.00
4	Catch Basin	EA	5	$5,000	$25,000.00
5	Junction Structure	EA	5	$2,000	$10,000.00
6	Utility Relocation Allowance	LS	1	$909,100	$909,100.00
7	Remove 24" RCP	FT	355	$25	$8,786.25
8	Remove 33" RCP	FT	325	$33	$10,725.00
9	Remove 57" RCP	FT	1288	$55	$70,518.00
10	Remove 63" RCP	FT	974	$59	$57,709.50
11	Traffic Control	LS	1	$140,800	$140,800.00
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
13	Mobilization (10%)	LS	1	$574,800	$574,800.00
14	Miscellaneous Items (10%)	LS	1	$632,300	$632,300.00
	SUBTOTAL (CONSTRUCTION)				**$6,954,839**
15	Engineering and Design (8%)	LS	1	$556,400	$556,400
16	Surveying (1%)	LS	1	$69,600	$69,600
17	Construction Management (6%)	LS	1	$417,300	$417,300
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$1,043,300
	SUBTOTAL COST				$7,998,139
	CONTINGENCY			20%	$1,599,628
	TOTAL PROJECT				**$9,598,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 30
Nodes 402 - 430
Street: W Edinger Ave.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	341	$250	$85,250.00
2	Install 36" RCP*	FT	67	$250	$16,750.00
3	Install 42" RCP	FT	537	$275	$147,675.00
4	Install 48" RCP	FT	480	$290	$139,200.00
5	Install 48" RCP*	FT	969	$290	$281,010.00
6	Install 66" RCP	FT	2619	$395	$1,034,505.00
7	Install 14'x6.5' RCB	FT	56	$2,000	$112,000.00
8	Manhole	EA	16	$4,700	$75,200.00
9	Catch Basin	EA	10	$5,000	$50,000.00
10	Junction Structure	EA	10	$2,000	$20,000.00
11	Utility Relocation Allowance	LS	1	$392,400	$392,400.00
12	Remove 21" RCP	FT	341	$25	$8,439.75
13	Remove 27" RCP	FT	396	$27	$10,692.00
14	Remove 30" RCP	FT	478	$27	$12,906.00
15	Remove 36" RCP	FT	678	$38	$25,425.00
16	Remove 42" RCP	FT	780	$41	$32,175.00
17	Remove 48" RCP	FT	1304	$44	$56,724.00
18	Remove 66" RCP	FT	56	$59	$3,318.00
19	Traffic Control	LS	1	$63,400	$63,400.00
20	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
21	Mobilization (10%)	LS	1	$257,300	$257,300.00
22	Miscellaneous Items (10%)	LS	1	$283,000	$283,000.00
			SUBTOTAL (CONSTRUCTION)		**$3,112,370**
23	Engineering and Design (8%)	LS	1	$249,000	$249,000
24	Surveying (1%)	LS	1	$31,200	$31,200
25	Construction Management (6%)	LS	1	$186,800	$186,800
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$467,000
			SUBTOTAL COST		$3,579,370
			CONTINGENCY	20%	$715,874
			TOTAL PROJECT		**$4,295,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 31
Nodes 430 - 435
Street: S Flower St.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	25	$250	$6,250.00
2	Install 14'x6.5' RCB	FT	1636	$2,000	$3,272,000.00
3	Manhole	EA	5	$4,700	$23,500.00
4	Catch Basin	EA	3	$5,000	$15,000.00
5	Junction Structure	EA	3	$2,000	$6,000.00
6	Utility Relocation Allowance	LS	1	$664,600	$664,600.00
7	Remove 12" RCP	FT	25	$21	$525.00
8	Remove 66" RCP	FT	1636	$59	$96,933.00
9	Traffic Control	LS	1	$102,700	$102,700.00
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
11	Mobilization (10%)	LS	1	$419,300	$419,300.00
12	Miscellaneous Items (10%)	LS	1	$461,200	$461,200.00
	SUBTOTAL (CONSTRUCTION)				**$5,073,008**
13	Engineering and Design (8%)	LS	1	$405,900	$405,900
14	Surveying (1%)	LS	1	$50,800	$50,800
15	Construction Management (6%)	LS	1	$304,400	$304,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$761,100
	SUBTOTAL COST				$5,834,108
	CONTINGENCY			20%	$1,166,822
	TOTAL PROJECT				**$7,001,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi

Total Cost - SubAreas 28 - 31

SubArea	Total Project Cost
28	$6,444,000
29	$9,598,000
30	$4,295,000
31	$7,001,000
Total	**$27,338,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 32
Nodes 435 - 440
Street: S Flower St., E Gertrude Pl

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	25	$290	$7,250.00
2	Install 14'x6.5' RCB	FT	937	$2,000	$1,874,000.00
3	Manhole	EA	3	$4,700	$14,100.00
4	Catch Basin	EA	1	$5,000	$5,000.00
5	Junction Structure	EA	1	$2,000	$2,000.00
6	Utility Relocation Allowance	LS	1	$380,500	$380,500.00
7	Remove 27" RCP	FT	25	$27	$675.00
8	Remove 66" RCP	FT	937	$59	$55,517.25
9	Traffic Control	LS	1	$58,800	$58,800.00
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
11	Mobilization (10%)	LS	1	$240,300	$240,300.00
12	Miscellaneous Items (10%)	LS	1	$264,400	$264,400.00
			SUBTOTAL (CONSTRUCTION)		**$2,907,542**
13	Engineering and Design (8%)	LS	1	$232,700	$232,700
14	Surveying (1%)	LS	1	$29,100	$29,100
15	Construction Management (6%)	LS	1	$174,500	$174,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$436,300
			SUBTOTAL COST		$3,343,842
			CONTINGENCY	20%	$668,768
			TOTAL PROJECT		**$4,013,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 33
Nodes 445 - 469
Street: S Flower St., Warner Ave

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 18" RCP*	FT	66	$140	$9,240.00
2	Install 48" RCP*	FT	240	$290	$69,600.00
3	Install 60" RCP*	FT	765	$365	$279,225.00
4	Install 8'x8' RCB*	FT	1428	$1,700	$2,427,600.00
5	Install Double 8'x8' RCB	FT	918	$3,400	$3,121,200.00
6	Install Double 10'x8' RCB	FT	1216	$3,800	$4,620,800.00
7	Install Double 12'x8' RCB	FT	67	$4,200	$281,400.00
8	Install Double 14'x6.5' RCB	FT	655	$4,000	$2,620,000.00
9	Manhole	EA	16	$4,700	$75,200.00
10	Catch Basin	EA	10	$5,000	$50,000.00
11	Junction Structure	EA	10	$2,000	$20,000.00
12	Utility Relocation Allowance	LS	1	$2,699,100	$2,699,100.00
13	Remove 66" RCP	FT	655	$59	$38,808.75
14	Remove 69" RCP	FT	2201	$64	$140,313.75
15	Traffic Control	LS	1	$412,700	$412,700.00
16	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
17	Mobilization (10%)	LS	1	$1,679,200	$1,679,200.00
18	Miscellaneous Items (10%)	LS	1	$1,847,100	$1,847,100.00
			SUBTOTAL (CONSTRUCTION)		**$20,317,648**
19	Engineering and Design (8%)	LS	1	$1,625,500	$1,625,500
20	Surveying (1%)	LS	1	$203,200	$203,200
21	Construction Management (6%)	LS	1	$1,219,100	$1,219,100
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$3,047,800
			SUBTOTAL COST		$23,365,448
			CONTINGENCY	20%	$4,673,090
			TOTAL PROJECT		**$28,039,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 34
Nodes 440 - 445
Street: S Flower St., W Anahurst Pl

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	25	$290	$7,250.00
2	Install 14'x6.5' RCB	FT	647	$2,000	$1,294,000.00
3	Manhole	EA	2	$4,700	$9,400.00
4	Catch Basin	EA	1	$5,000	$5,000.00
5	Junction Structure	EA	1	$2,000	$2,000.00
6	Utility Relocation Allowance	LS	1	$263,600	$263,600.00
7	Remove 66" RCP	FT	647	$59	$38,334.75
8	Remove 12" RCP	FT	25	$21	$525.00
9	Traffic Control	LS	1	$40,700	$40,700.00
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
11	Mobilization (10%)	LS	1	$166,600	$166,600.00
12	Miscellaneous Items (10%)	LS	1	$183,300	$183,300.00
	SUBTOTAL (CONSTRUCTION)				**$2,015,710**
13	Engineering and Design (8%)	LS	1	$161,300	$161,300
14	Surveying (1%)	LS	1	$20,200	$20,200
15	Construction Management (6%)	LS	1	$121,000	$121,000
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$302,500
	SUBTOTAL COST				$2,318,210
	CONTINGENCY			20%	$463,642
	TOTAL PROJECT				**$2,782,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 35
Nodes 457 - 469
Street: Bristol St, W Warner Ave.

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP*	FT	714	$290	$207,060.00
2	Install Double 42" RCP	FT	134	$550	$73,700.00
3	Install 54" RCP*	FT	1125	$300	$337,500.00
4	Install 60" RCP*	FT	1855	$365	$677,075.00
5	Install 60" RCP	FT	25	$365	$9,125.00
6	Install 72" RCP	FT	25	$425	$10,625.00
7	Install Double 10'x6' RCB	FT	2592	$216	$559,872.00
8	Install 14'x6.5' RCB	FT	668	$2,000	$1,336,000.00
9	Manhole	EA	10	$4,700	$47,000.00
10	Catch Basin	EA	6	$5,000	$30,000.00
11	Junction Structure	EA	6	$2,000	$12,000.00
12	Utility Relocation Allowance	LS	1	$603,900	$603,900.00
13	Remove 12" RCP	FT	134	$21	$2,814.00
14	Remove 36" RCP	FT	50	$38	$1,875.00
15	Remove 42" RCP	FT	2592	$41	$106,920.00
16	Remove 8'x6' RCB	FT	668	$80	$53,607.00
17	Traffic Control	LS	1	$95,600	$95,600.00
18	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
19	Mobilization (10%)	LS	1	$388,900	$388,900.00
20	Miscellaneous Items (10%)	LS	1	$427,800	$427,800.00
	SUBTOTAL (CONSTRUCTION)				**$4,705,613**
21	Engineering and Design (8%)	LS	1	$376,500	$376,500
22	Surveying (1%)	LS	1	$47,100	$47,100
23	Construction Management (6%)	LS	1	$282,400	$282,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$706,000
	SUBTOTAL COST				$5,411,613
	CONTINGENCY			20%	$1,082,323
	TOTAL PROJECT				**$6,494,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi

Total Cost - SubAreas 32 - 35

SubArea	Total Project Cost
32	$4,013,000
33	$28,039,000
34	$2,782,000
35	$6,494,000
Total	**$41,328,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 36
Nodes 474 - 479
Street: W Central Ave., Delhi Channel

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 42" RCP*	FT	253	$275	$69,575.00
2	Install 48" RCP*	FT	352	$290	$102,080.00
3	Install 48" RCP	FT	124	$290	$35,960.00
4	Install 14'x6.5' RCB	FT	15	$2,000	$30,000.00
5	Manhole	EA	0	$4,700	$0.00
6	Catch Basin	EA	0	$5,000	$0.00
7	Junction Structure	EA	0	$2,000	$0.00
8	Utility Relocation Allowance	LS	1	$13,200	$13,200.00
9	Remove 24" RCP	FT	124	$25	$3,069.00
10	Remove 8'x6' RCB	FT	15	$80	$1,203.75
11	Traffic Control	LS	1	$2,200	$2,200.00
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
13	Mobilization (10%)	LS	1	$9,100	$9,100.00
14	Miscellaneous Items (10%)	LS	1	$10,000	$10,000.00
	SUBTOTAL (CONSTRUCTION)				**$281,388**
1	Engineering and Design (8%)	LS	1	$22,600	$22,600
2	Surveying (1%)	LS	1	$2,900	$2,900
3	Construction Management (6%)	LS	1	$16,900	$16,900
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$42,400
	SUBTOTAL COST				$323,788
	CONTINGENCY			20%	$64,758
	TOTAL PROJECT				**$389,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 38
Nodes 482 - 488
Street: S Shelton St, Dyer Rd

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP*	FT	62	$165	$10,230.00
2	Install 36" RCP*	FT	37	$250	$9,250.00
3	Install 66" RCP*	FT	2683	$395	$1,059,785.00
4	Install 66" RCP	FT	76	$395	$30,020.00
5	Install Double 66" RCP	FT	1033	$790	$816,070.00
6	Manhole	EA	9	$4,700	$42,300.00
7	Catch Basin	EA	5	$5,000	$25,000.00
8	Junction Structure	EA	5	$2,000	$10,000.00
9	Utility Relocation Allowance	LS	1	$400,600	$400,600.00
10	Remove 54" RCP	FT	296	$45	$13,320.00
11	Remove 57" RCP	FT	611	$55	$33,452.25
12	Remove 60" RCP	FT	202	$55	$11,059.50
13	Traffic Control	LS	1	$61,900	$61,900.00
14	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
15	Mobilization (10%)	LS	1	$252,800	$252,800.00
16	Miscellaneous Items (10%)	LS	1	$278,100	$278,100.00
	SUBTOTAL (CONSTRUCTION)				**$3,058,887**
17	Engineering and Design (8%)	LS	1	$244,800	$244,800
18	Surveying (1%)	LS	1	$30,600	$30,600
19	Construction Management (6%)	LS	1	$183,600	$183,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$459,000
	SUBTOTAL COST				$3,517,887
	CONTINGENCY			20%	$703,577
	TOTAL PROJECT				**$4,221,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 40
Nodes 508 - 522
Street: E Central Ave., Cypress Ave., Main St., Delhi Channel

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install Double 66" RCP	FT	974	$790	$769,460.00
2	Manhole	EA	3	$4,700	$14,100.00
3	Catch Basin	EA	1	$5,000	$5,000.00
4	Junction Structure	EA	1	$2,000	$2,000.00
5	Utility Relocation Allowance	LS	1	$158,200	$158,200.00
6	Remove 84" RCP	FT	974	$74	$71,589.00
7	Traffic Control	LS	1	$25,900	$25,900.00
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
9	Mobilization (10%)	LS	1	$105,200	$105,200.00
10	Miscellaneous Items (10%)	LS	1	$115,700	$115,700.00
	SUBTOTAL (CONSTRUCTION)				**$1,272,149**
11	Engineering and Design (8%)	LS	1	$101,800	$101,800
12	Surveying (1%)	LS	1	$12,800	$12,800
13	Construction Management (6%)	LS	1	$76,400	$76,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$191,000
	SUBTOTAL COST				$1,463,149
	CONTINGENCY			20%	$292,630
	TOTAL PROJECT				**$1,756,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi

Total Cost - SubAreas 36 - 40

SubArea	Total Project Cost
36	$389,000
37	$0
38	$4,221,000
39	$0
40	$1,756,000
Total	**$6,366,000**

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi, SUBAREA 41
Nodes 526 - 534
Street: Alton Ave., Bradford Rd., Parapet Pl

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 60" RCP*	FT	643	$365	$234,695.00
2	Install 60" RCP	FT	81	$365	$29,565.00
3	Install Double 60" RCP	FT	657	$730	$479,610.00
4	Manhole	EA	4	$4,700	$18,800.00
5	Catch Basin	EA	2	$5,000	$10,000.00
6	Junction Structure	EA	2	$2,000	$4,000.00
7	Utility Relocation Allowance	LS	1	$155,400	$155,400.00
8	Remove 54" RCP	FT	673	$45	$30,285.00
9	Remove 60" RCP	FT	65	$55	$3,558.75
10	Traffic Control	LS	1	$24,400	$24,400.00
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
12	Mobilization (10%)	LS	1	$99,600	$99,600.00
13	Miscellaneous Items (10%)	LS	1	$109,500	$109,500.00
SUBTOTAL (CONSTRUCTION)					**$1,204,414**
14	Engineering and Design (8%)	LS	1	$96,400	$96,400
15	Surveying (1%)	LS	1	$12,100	$12,100
16	Construction Management (6%)	LS	1	$72,300	$72,300
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$180,800
SUBTOTAL COST					$1,385,214
CONTINGENCY				20%	$277,043
TOTAL PROJECT					**$1,662,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi, SUBAREA 42
Nodes 533 - 534
Street: Alton Ave., Delhi Channel

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	143	$290	$41,470.00
2	Manhole	EA	0	$4,700	$0.00
3	Catch Basin	EA	0	$5,000	$0.00
4	Junction Structure	EA	0	$2,000	$0.00
5	Utility Relocation Allowance	LS	1	$8,300	$8,300.00
6	Remove 24" RCP	FT	143	$25	$3,539.25
7	Traffic Control	LS	1	$1,400	$1,400.00
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
9	Mobilization (10%)	LS	1	$6,000	$6,000.00
10	Miscellaneous Items (10%)	LS	1	$6,600	$6,600.00
	SUBTOTAL (CONSTRUCTION)				**$72,309**
1	Engineering and Design (8%)	LS	1	$5,800	$5,800
2	Surveying (1%)	LS	1	$800	$800
3	Construction Management (6%)	LS	1	$4,400	$4,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$11,000
	SUBTOTAL COST				$83,309
	CONTINGENCY			20%	$16,662
	TOTAL PROJECT				**$100,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 44
Nodes 546.4 - 547
Street: Columbine Ave., Delhi Channel

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 54" RCP	FT	76	$300	$22,800.00
2	Manhole	EA	0	$4,700	$0.00
3	Catch Basin	EA	0	$5,000	$0.00
4	Junction Structure	EA	0	$2,000	$0.00
5	Utility Relocation Allowance	LS	1	$4,600	$4,600.00
6	Remove 30" RCP	FT	76	$27	$2,052.00
7	Traffic Control	LS	1	$800	$800.00
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
9	Mobilization (10%)	LS	1	$3,600	$3,600.00
10	Miscellaneous Items (10%)	LS	1	$3,900	$3,900.00
	SUBTOTAL (CONSTRUCTION)				**$42,752**
11	Engineering and Design (8%)	LS	1	$3,500	$3,500
12	Surveying (1%)	LS	1	$500	$500
13	Construction Management (6%)	LS	1	$2,600	$2,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$6,600
	SUBTOTAL COST				$49,352
	CONTINGENCY			20%	$9,870
	TOTAL PROJECT				**$59,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 45

Nodes 549 - 555

Street: Alpine Ave., Woodland Pl

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 7'x7' RCB	FT	143	$535	$76,505.00
2	Manhole	EA	0	$4,700	$0.00
3	Catch Basin	EA	0	$5,000	$0.00
4	Junction Structure	EA	0	$2,000	$0.00
5	Utility Relocation Allowance	LS	1	$15,400	$15,400.00
6	Remove 42" RCP	FT	143	$44	$6,220.50
7	Traffic Control	LS	1	$2,500	$2,500.00
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
9	Mobilization (10%)	LS	1	$10,600	$10,600.00
10	Miscellaneous Items (10%)	LS	1	$11,700	$11,700.00
	SUBTOTAL (CONSTRUCTION)				**$127,926**
11	Engineering and Design (8%)	LS	1	$10,300	$10,300
12	Surveying (1%)	LS	1	$1,300	$1,300
13	Construction Management (6%)	LS	1	$7,700	$7,700
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$19,300
	SUBTOTAL COST				$147,226
	CONTINGENCY			20%	$29,445
	TOTAL PROJECT				**$177,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 46
Nodes 558 - 569
Street: Main St., Birch St., MacArthur Blvd

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 42" RCP	FT	646	$275	$177,650.00
2	Install 48" RCP	FT	548	$290	$158,920.00
3	Install 66" RCP	FT	711	$395	$280,845.00
4	Install 72" RCP	FT	1549	$425	$658,325.00
5	Manhole	EA	11	$4,700	$51,700.00
6	Catch Basin	EA	6	$5,000	$30,000.00
7	Junction Structure	EA	6	$2,000	$12,000.00
8	Utility Relocation Allowance	LS	1	$273,900	$273,900.00
9	Remove 36" RCP	FT	646	$38	$24,225.00
10	Remove 42" RCP	FT	1482	$44	$64,467.00
11	Remove 51" RCP	FT	1326	$45	$59,670.00
12	Traffic Control	LS	1	$45,600	$45,600.00
13	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
14	Mobilization (10%)	LS	1	$184,300	$184,300.00
15	Miscellaneous Items (10%)	LS	1	$202,700	$202,700.00
SUBTOTAL (CONSTRUCTION)					**$2,229,302**
16	Engineering and Design (8%)	LS	1	$178,400	$178,400
17	Surveying (1%)	LS	1	$22,300	$22,300
18	Construction Management (6%)	LS	1	$133,800	$133,800
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$334,500
SUBTOTAL COST					$2,563,802
CONTINGENCY				20%	$512,760
TOTAL PROJECT					**$3,077,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi

Total Cost - SubAreas 41 - 46

SubArea	Total Project Cost
41	$1,662,000
42	$100,000
43	$0
44	$59,000
45	$177,000
46	$3,077,000
Total	**$5,075,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 47
Nodes 572 - 578
Street: Olive St., MacArthur Blvd., Delhi Channel

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	82	$290	$23,780.00
2	Install 6'x4' RCB	FT	134	$425	$56,950.00
3	Manhole	EA	0	$4,700	$0.00
4	Catch Basin	EA	0	$5,000	$0.00
5	Junction Structure	EA	0	$2,000	$0.00
6	Utility Relocation Allowance	LS	1	$16,200	$16,200.00
7	Remove 33" RCP	FT	82	$33	$2,706.00
8	Remove 36" RCP	FT	134	$38	$5,025.00
9	Traffic Control	LS	1	$2,700	$2,700.00
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
11	Mobilization (10%)	LS	1	$11,300	$11,300.00
12	Miscellaneous Items (10%)	LS	1	$12,400	$12,400.00
	SUBTOTAL (CONSTRUCTION)				**$136,061**
13	Engineering and Design (8%)	LS	1	$10,900	$10,900
14	Surveying (1%)	LS	1	$1,400	$1,400
15	Construction Management (6%)	LS	1	$8,200	$8,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$20,500
	SUBTOTAL COST				$156,561
	CONTINGENCY			20%	$31,312
	TOTAL PROJECT				**$188,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Delhi, SUBAREA 48

Nodes 581 - 584

Street: Murphy, Woodland Pl, Garnsey St., Parton St., Vaness St., Ross St.,

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	886	$250	$221,500.00
2	Install 84" RCP	FT	431	$490	$211,190.00
3	Manhole	EA	4	$4,700	$18,800.00
4	Catch Basin	EA	2	$5,000	$10,000.00
5	Junction Structure	EA	2	$2,000	$4,000.00
6	Utility Relocation Allowance	LS	1	$93,100	$93,100.00
7	Remove 27" RCP	FT	275	$27	$7,425.00
8	Remove 33" RCP	FT	438	$33	$14,454.00
9	Remove 42" RCP	FT	431	$41	$17,778.75
10	Remove 21" RCP	FT	173	$25	$4,281.75
11	Traffic Control	LS	1	$15,300	$15,300.00
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
13	Mobilization (10%)	LS	1	$62,300	$62,300.00
14	Miscellaneous Items (10%)	LS	1	$68,600	$68,600.00
	SUBTOTAL (CONSTRUCTION)				**$753,730**
15	Engineering and Design (8%)	LS	1	$60,300	$60,300
16	Surveying (1%)	LS	1	$7,600	$7,600
17	Construction Management (6%)	LS	1	$45,300	$45,300
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$113,200
	SUBTOTAL COST				$866,930
	CONTINGENCY			20%	$173,386
	TOTAL PROJECT				**$1,040,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi

Total Cost - SubAreas 47 - 58

SubArea	Total Project Cost
47	$188,000
48	$1,040,000
49	$0
50	$0
51	$0
52	$0
53	$0
54	$0
55	$0
56	$0
57	$0
58	$0
Total	**$1,228,000**

Master Plan of Storm Drainage for City of Santa Ana
Watershed Delhi

Total Cost - SubAreas 1 - 58

SubAreas	Total Project Cost
1 - 3	$5,908,000
4 - 11	$4,224,000
12 - 15	$14,595,000
16 - 19	$16,816,000
20 - 23	$19,761,000
24 - 27	$12,314,000
28 - 31	$27,338,000
32 - 35	$41,328,000
36 - 40	$6,366,000
41 - 46	$5,075,000
47 - 58	$1,228,000
Total	**$154,953,000**

GARDENS COST ESTIMATES

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 1
Nodes 103 - 127
Streets: Between 11th & Raitt and 1st & Center

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP	FT	62	$190	$11,780
2	Install DBL 4' x 3' RCB	FT	1018	$431	$438,758
3	Manhole	EA	3	$4,700	$14,100
4	Catch Basin	EA	2	$5,000	$10,000
5	Junction Structure	EA	2	$2,000	$4,000
6	Utility Relocation Allowance	LS	1	$95,800	$95,800
7	Remove 30" RCP	FT	31	$31	$963
8	Remove 5.4' x 3.3' ARCH	FT	1018	$31	$31,609
9	Traffic Control	LS	1	$15,400	$15,400
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$62,800	$62,800
12	Miscellaneous Items (10%)	LS	1	$69,100	$69,100
	SUBTOTAL (CONSTRUCTION)				**$759,309**
1	Engineering and Design (8%)	LS	1	$60,800	$60,800
2	Surveying (1%)	LS	1	$7,600	$7,600
3	Construction Management (6%)	LS	1	$45,600	$45,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$114,000
	SUBTOTAL COST				$873,309
	CONTINGENCY			20%	$174,661.89
	TOTAL PROJECT				**$1,048,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Gardens

Total Cost - SubAreas 1, 2, and 3

SubArea	Total Project Cost
1	$1,048,000
2	$0
3	$0
Total	**$1,048,000**

Master Plan of Storm Drainage for City of Santa Ana
Watershed Gardens, SUBAREA 14
Nodes 203 - 210
Street: Center Street and Edinger

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP	FT	83	$190	$15,770
2	Install 42" RCP	FT	47	$316	$14,852
3	Install 48" RCP	FT	241	$334	$80,494
4	Install 54" RCP	FT	647	$345	$223,215
5	Install 72" RCP	FT	1283	$466	$597,878
6	Manhole	EA	1	$4,700	$4,700
7	Catch Basin	EA	0	$5,000	$0
8	Junction Structure	EA	0	$2,000	$0
9	Utility Relocation Allowance	LS	1	$187,400	$187,400
10	Remove 18" RCP	FT	83	$24	$2,004
11	Remove 36" RCP	FT	935	$43	$40,392
12	Remove 54" RCP	FT	1283	$51.75	$66,395
13	Traffic Control	LS	1	$31,400	$31,400
14	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
15	Mobilization (10%)	LS	1	$127,000	$127,000
16	Miscellaneous Items (10%)	LS	1	$139,700	$139,700
SUBTOTAL (CONSTRUCTION)					**$1,536,201**
17	Engineering and Design (8%)	LS	1	$122,900	$122,900
18	Surveying (1%)	LS	1	$15,400	$15,400
19	Construction Management (6%)	LS	1	$92,200	$92,200
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$230,500
SUBTOTAL COST					$1,766,701
CONTINGENCY				20%	$353,340
TOTAL PROJECT					**$2,120,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 18
Nodes 244 - 245
Street: Joanne and Occidental

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 66" RCP	FT	38	$431	$16,378
2	Install 14' x 9' Rectangular channel	FT	416	$2,760	$1,148,160
3	Install 18' x 9' Rectangular channel	FT	935	$3,105	$2,903,175
4	Manhole	EA	4	$4,700	$18,800
5	Catch Basin	EA	2	$5,000	$10,000
6	Junction Structure	EA	2	$2,000	$4,000
7	Utility Relocation Allowance	LS	1	$816,900	$816,900
8	Remove 54" RCP	FT	38	$52	$1,967
9	Remove 4' x 9' TRAP	FT	1351	$466	$629,228
10	Traffic Control	LS	1	$141,500	$141,500
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
12	Mobilization (10%)	LS	1	$567,900	$567,900
13	Miscellaneous Items (10%)	LS	1	$624,700	$624,700
			SUBTOTAL (CONSTRUCTION)		**$6,871,330**
14	Engineering and Design (8%)	LS	1	$549,800	$549,800
15	Surveying (1%)	LS	1	$68,800	$68,800
16	Construction Management (6%)	LS	1	$412,300	$412,300
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$1,030,900
			SUBTOTAL COST		$7,902,230
			CONTINGENCY	20%	$1,580,446
			TOTAL PROJECT		**$9,483,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 19
Nodes 239 - 241
Street: Occidental

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 18' x 9' Rectangular channel	FT	223	$3,105	$692,415
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$138,500	$138,500
6	Remove 4' x 9' TRAP	FT	223	$466	$103,862
7	Traffic Control	LS	1	$23,900	$23,900
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$96,400	$96,400
10	Miscellaneous Items (10%)	LS	1	$106,100	$106,100
	SUBTOTAL (CONSTRUCTION)				**$1,166,177**
11	Engineering and Design (8%)	LS	1	$93,300	$93,300
12	Surveying (1%)	LS	1	$11,700	$11,700
13	Construction Management (6%)	LS	1	$70,000	$70,000
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$175,000
	SUBTOTAL COST				$1,341,177
	CONTINGENCY			20%	$268,235
	TOTAL PROJECT				**$1,609,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 20
Nodes 248 - 248.5
Street: Glenwood

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 2-36" RCP	FT	1192	$576	$686,592
2	Install 48" RCP	FT	132	$334	$44,088
2	Install 18' x 9' Rectangular channel	FT	1268	$3,105	$3,937,140
3	Manhole	EA	8	$4,700	$37,600
4	Catch Basin	EA	5	$5,000	$25,000
5	Junction Structure	EA	5	$2,000	$10,000
6	Utility Relocation Allowance	LS	1	$948,100	$948,100
7	Remove 24" RCP	FT	1192	$29	$33,972
8	Remove 33" RCP	FT	132	$38	$5,009
9	Remove 4' x 9' TRAP	FT	1268	$466	$590,571
10	Traffic Control	LS	1	$143,400	$143,400
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
12	Mobilization (10%)	LS	1	$646,700	$646,700
13	Miscellaneous Items (10%)	LS	1	$711,400	$711,400
SUBTOTAL (CONSTRUCTION)					**$7,824,572**
14	Engineering and Design (8%)	LS	1	$626,000	$626,000
15	Surveying (1%)	LS	1	$78,300	$78,300
16	Construction Management (6%)	LS	1	$469,500	$469,500
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$1,173,800
SUBTOTAL COST					$8,998,372
CONTINGENCY				20%	$1,799,674
TOTAL PROJECT					**$10,798,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens

Total Cost - SubAreas 4 - 20

SubArea	Total Project Cost
4	$0
5	$0
6	$0
7	$0
8	$0
9	$0
10	$0
11	$0
12	$0
13	$0
14	$2,120,000
15	$0
16	$0
17	$0
18	$9,483,000
19	$1,609,000
20	$10,798,000
Total	**$24,010,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 21
Nodes 261 - 265
Street: Rene

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	195	$288	$56,160
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$11,300	$11,300
6	Remove 30" RCP	FT	195	$31	$6,055
7	Traffic Control	LS	1	$1,900	$1,900
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$8,100	$8,100
10	Miscellaneous Items (10%)	LS	1	$8,900	$8,900
	SUBTOTAL (CONSTRUCTION)				**$97,415**
11	Engineering and Design (8%)	LS	1	$7,800	$7,800
12	Surveying (1%)	LS	1	$1,000	$1,000
13	Construction Management (6%)	LS	1	$5,900	$5,900
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$14,700
	SUBTOTAL COST				$112,115
	CONTINGENCY			20%	$22,423
	TOTAL PROJECT				**$135,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens

Total Cost - SubAreas 21 & 41

SubArea	Total Project Cost
21	$135,000
41	$0
Total	**$135,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 23
Nodes 259 - 260
Street: Pendleton

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	130	$334	$43,420
2	Install 18' x 9' REC	FT	30	$3,105	$93,150
3	Manhole	EA	0	$4,700	$0
4	Catch Basin	EA	0	$5,000	$0
5	Junction Structure	EA	0	$2,000	$0
6	Utility Relocation Allowance	LS	1	$27,400	$27,400
7	Remove 36" RCP	FT	130	$43	$5,616
8	Remove 4' x 9' TRAP	FT	30	$31	$931.50
9	Traffic Control	LS	1	$4,300	$4,300
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$18,000	$18,000
12	Miscellaneous Items (10%)	LS	1	$19,800	$19,800
SUBTOTAL (CONSTRUCTION)					**$217,618**
1	Engineering and Design (8%)	LS	1	$17,500	$17,500
2	Surveying (1%)	LS	1	$2,200	$2,200
3	Construction Management (6%)	LS	1	$13,100	$13,100
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$32,800
SUBTOTAL COST					$250,418
CONTINGENCY				20%	$50,084
TOTAL PROJECT					**$301,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 24
Nodes 269 - 271
Street: Warner and Pacific

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 18' x 9' Rectangular channel	FT	894	$3,105	$2,775,870
2	Manhole	EA	2	$4,700	$9,400
3	Catch Basin	EA	1	$5,000	$5,000
4	Junction Structure	EA	1	$2,000	$2,000
5	Utility Relocation Allowance	LS	1	$558,500	$558,500
6	Remove 4' x 9' TRAP	FT	894	$466	$416,381
7	Traffic Control	LS	1	$96,300	$96,300
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$386,900	$386,900
10	Miscellaneous Items (10%)	LS	1	$425,600	$425,600
SUBTOTAL (CONSTRUCTION)					**$4,680,951**
11	Engineering and Design (8%)	LS	1	$374,500	$374,500
12	Surveying (1%)	LS	1	$46,900	$46,900
13	Construction Management (6%)	LS	1	$280,900	$280,900
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$702,300
SUBTOTAL COST					$5,383,251
CONTINGENCY				20%	$1,076,650
TOTAL PROJECT					**$6,460,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Gardens, SUBAREA 29
Nodes 313 - 315
Street: Adams and Rita

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 30" RCP	FT	97	$207	$20,079.00
2	Install 42" RCP	FT	141	$316	$44,556.00
3	Install 22' x 10' Rectangular channel	FT	503	$3,450	$1,735,350.00
4	Install 18' x 14' Rectangular channel	FT	288	$3,680	$1,059,840.00
5	Install 18' x 14.5' Rectangular channel	FT	1150	$3,680	$4,232,000.00
6	Manhole	EA	7	$4,700	$32,900.00
7	Catch Basin	EA	1	$5,000	$5,000.00
8	Junction Structure	EA	1	$2,000	$2,000.00
9	Utility Relocation Allowance	LS	1	$1,426,400	$1,426,400.00
10	Remove 21" RCP	FT	97	$29	$2,764.50
11	Remove 30" RCP	FT	37	$31	$1,148.85
12	Remove 36" RCP	FT	104	$43	$4,492.80
13	Remove 4' x 14' Trapezoidal channel (1.5:1 slope)	FT	288	$561	$161,481.60
14	Remove 4' x 14.5' Trapezoidal channel (1.5:1 slope)	FT	1150	$983	$1,130,737.50
15	Remove 4' x 10' Trapezoidal channel (1.5:1 slope)	FT	503	$185	$92,803.50
16	Traffic Control	LS	1	$214,300	$214,300.00
17	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
18	Mobilization (10%)	LS	1	$1,017,100	$1,017,100.00
19	Miscellaneous Items (10%)	LS	1	$1,118,800	$1,118,800.00
	SUBTOTAL (CONSTRUCTION)				**$12,306,754**
20	Engineering and Design (8%)	LS	1	$984,600	$984,600
21	Surveying (1%)	LS	1	$123,100	$123,100
22	Construction Management (6%)	LS	1	$738,500	$738,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$1,846,200
	SUBTOTAL COST				$14,152,954
	CONTINGENCY			20%	$2,830,591
	TOTAL PROJECT				**$16,984,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 30
Nodes 318 - 325
Street: Bristol and Segerstrom

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 18" RCP	FT	57	$161	$9,177.00
2	Install 36" RCP	FT	165	$288	$47,520.00
3	Install 22' x 9' Rectangular channel	FT	700	$1,230	$861,000.00
4	Install 22' x 10' Rectangular channel	FT	382	$3,450	$1,317,900.00
5	Manhole	EA	4	$4,700	$18,800.00
6	Catch Basin	EA	2	$5,000	$10,000.00
7	Junction Structure	EA	2	$2,000	$4,000.00
8	Utility Relocation Allowance	LS	1	$453,700	$453,700.00
9	Remove 18" RCP	FT	57	$24	$1,376.55
10	Remove 36" RCP	FT	165	$43	$7,128.00
11	Remove 4' x 10' Trapezoidal channel	FT	382	$185	$70,479.00
12	Remove 14' x 9' Trapezoidal channel	FT	700	$548	$383,355.00
13	Traffic Control	LS	1	$82,000	$82,000.00
14	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
15	Mobilization (10%)	LS	1	$327,200	$327,200.00
16	Miscellaneous Items (10%)	LS	1	$359,900	$359,900.00
	SUBTOTAL (CONSTRUCTION)				**$3,958,536**
17	Engineering and Design (8%)	LS	1	$316,700	$316,700
18	Surveying (1%)	LS	1	$39,600	$39,600
19	Construction Management (6%)	LS	1	$237,600	$237,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$593,900
	SUBTOTAL COST				$4,552,436
	CONTINGENCY			20%	$910,487
	TOTAL PROJECT				**$5,463,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Gardens

Total Cost - SubAreas 22 - 30

SubArea	Total Project Cost
22	$0
23	$301,000
24	$6,460,000
25	$0
26	$0
27	$0
28	$0
29	$16,984,000
30	$5,463,000
Total	**$29,208,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 31
Nodes 326 - 329
Street: Carriage

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 40' x 9' Rectangular channel	FT	574	$3,738	$2,145,612.00
2	Manhole	EA	1	$4,700	$4,700.00
3	Catch Basin	EA	1	$5,000	$5,000.00
4	Junction Structure	EA	1	$2,000	$2,000.00
5	Utility Relocation Allowance	LS	1	$431,500	$431,500.00
6	Remove 14' x 9' Trapezoidal channel	FT	434	$548	$237,680.10
7	Remove 14' x 9.5' Trapezoidal channel	FT	140	$530	$74,256.00
8	Traffic Control	LS	1	$71,900	$71,900.00
9	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
10	Mobilization (10%)	LS	1	$297,800	$297,800.00
11	Miscellaneous Items (10%)	LS	1	$327,600	$327,600.00
	SUBTOTAL (CONSTRUCTION)				**$3,603,048**
12	Engineering and Design (8%)	LS	1	$288,300	$288,300
13	Surveying (1%)	LS	1	$36,100	$36,100
14	Construction Management (6%)	LS	1	$216,200	$216,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$540,600
	SUBTOTAL COST				$4,143,648
	CONTINGENCY			20%	$828,730
	TOTAL PROJECT				**$4,972,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 32
Nodes 331 - 333
Street: Between Rita and Rene

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 40' x 9' Rectangular channel	FT	160	$3,738	$598,080.00
2	Install 40' x 10.5' Rectangular channel	FT	139	$4,945	$687,355.00
3	Install 40' x 11' Rectangular channel	FT	61	$5,060	$308,660.00
4	Manhole	EA	1	$4,700	$4,700.00
5	Catch Basin	EA	0	$5,000	$0.00
6	Junction Structure	EA	0	$2,000	$0.00
7	Utility Relocation Allowance	LS	1	$319,800	$319,800.00
8	Remove 14' x 9.5' Trapezoidal channel	FT	160	$530	$84,864.00
9	Remove 14' x 11' Trapezoidal channel	FT	139	$553	$76,853.10
10	Remove 14' x 12.5' Trapezoidal channel	FT	61	$575	$35,090.25
10	Traffic Control	LS	1	$52,900	$52,900.00
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
12	Mobilization (10%)	LS	1	$217,400	$217,400.00
13	Miscellaneous Items (10%)	LS	1	$239,100	$239,100.00
	SUBTOTAL (CONSTRUCTION)				**$2,629,802**
14	Engineering and Design (8%)	LS	1	$210,400	$210,400
15	Surveying (1%)	LS	1	$26,300	$26,300
16	Construction Management (6%)	LS	1	$157,800	$157,800
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$394,500
	SUBTOTAL COST				$3,024,302
	CONTINGENCY			20%	$604,860
	TOTAL PROJECT				**$3,629,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 33
Nodes 336 - 338
Street: Moore

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 40' x 11' Rectangular channel	FT	545	$5,060	$2,757,700.00
2	Manhole	EA	1	$4,700	$4,700.00
3	Catch Basin	EA	1	$5,000	$5,000.00
4	Junction Structure	EA	1	$2,000	$2,000.00
5	Utility Relocation Allowance	LS	1	$553,900	$553,900.00
6	Remove 14' x 12.5' Trapezoidal channel	FT	545	$575	$313,511.25
7	Traffic Control	LS	1	$92,500	$92,500.00
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
9	Mobilization (10%)	LS	1	$373,500	$373,500.00
10	Miscellaneous Items (10%)	LS	1	$410,800	$410,800.00
	SUBTOTAL (CONSTRUCTION)				**$4,518,611**
11	Engineering and Design (8%)	LS	1	$361,500	$361,500
12	Surveying (1%)	LS	1	$45,200	$45,200
13	Construction Management (6%)	LS	1	$271,200	$271,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$677,900
	SUBTOTAL COST				$5,196,511
	CONTINGENCY			20%	$1,039,302
	TOTAL PROJECT				**$6,236,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Gardens, SUBAREA 40
Nodes 391 - 398
Street: Sunflower, Sea Breeze, Plaza

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 18" RCP	FT	331	$161	$53,291.00
2	Install 24" RCP*	FT	27	$190	$5,130.00
3	Install 36" RCP	FT	561	$288	$161,568.00
4	Install 42" RCP	FT	915	$316	$289,140.00
5	Install 54" RCP	FT	385	$345	$132,825.00
6	Install 60" RCP	FT	140	$397	$55,580.00
7	Install 72" RCP	FT	2171	$466	$1,011,686.00
8	Manhole	EA	15	$4,700	$70,500.00
9	Catch Basin	EA	9	$5,000	$45,000.00
10	Junction Structure	EA	9	$2,000	$18,000.00
11	Utility Relocation Allowance	LS	1	$368,600	$368,600.00
12	Remove 18" RCP	FT	1625	$24	$39,243.75
13	Remove 36" RCP	FT	594	$43	$25,660.80
14	Remove 39" RCP	FT	140	$47	$6,636.00
15	Remove 54" RCP	FT	1642	$52	$84,973.50
16	Remove 60" RCP	FT	529	$60	$31,501.95
17	Traffic Control	LS	1	$61,000	$61,000.00
18	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
19	Mobilization (10%)	LS	1	$246,600	$246,600.00
20	Miscellaneous Items (10%)	LS	1	$271,200	$271,200.00
	SUBTOTAL (CONSTRUCTION)				**$2,983,136**
21	Engineering and Design (8%)	LS	1	$238,700	$238,700
22	Surveying (1%)	LS	1	$29,900	$29,900
23	Construction Management (6%)	LS	1	$179,000	$179,000
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$447,600
	SUBTOTAL COST				$3,430,736
	CONTINGENCY			20%	$686,147
	TOTAL PROJECT				**$4,117,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Gardens

Total Cost - SubAreas 31 - 40

SubArea	Total Project Cost
31	$4,972,000
32	$3,629,000
33	$6,236,000
34	$0
35	$0
36	$0
37	$0
38	$0
39	$0
40	$4,117,000
Total	**$18,954,000**

Master Plan of Storm Drainage for City of Santa Ana
Watershed Gardens

Total Cost - SubAreas 1 - 40

SubAreas	Total Project Cost
1 - 3	$1,048,000
4 - 20	$24,010,000
21 & 41	$135,000
22 - 30	$29,208,000
31 - 40	$18,954,000
Total	**$73,355,000**

GREENVILLE COST ESTIMATES

Master Plan of Storm Drainage for City of Santa Ana
Watershed Greenville Banning, SUBAREA 1
Nodes 112 - 175
Streets: Fairview (between Civic Center Drive and Edinger)

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP*	FT	208	$190	$39,520
2	Install 42" RCP*	FT	38	$316	$12,008
3	Install 48" RCP	FT	282	$334	$94,188
4	Install 60" RCP	FT	1969	$397	$781,693
5	Install 66" RCP	FT	767	$431	$330,577
6	Install 72" RCP	FT	2634	$466	$1,227,444
7	Install 12' x 3.75' REC	FT	961	$538	$516,682
8	Install 12' x 3.95' REC	FT	872	$615	$536,280
9	Install 12' x 4.46' REC	FT	89	$1,725	$153,525
10	Manhole	EA	25	$4,700	$117,500
11	Catch Basin	EA	15	$5,000	$75,000
12	Junction Structure	EA	15	$2,000	$30,000
13	Utility Relocation Allowance	LS	1	$775,000	$775,000
14	Remove 18" RCP	FT	38	$24	$918
15	Remove 24" RCP	FT	38	$29	$1,083
16	Remove 30" RCP	FT	244	$31.05	$7,576
17	Remove 54" RCP	FT	4326	$51.75	$223,871
18	Remove 60" RCP	FT	1044	$59.55	$62,170
19	Remove 4.5' x 3.75' TRAP	FT	961	$77.70	$74,670
20	Remove 4.5' x 3.95' TRAP	FT	872	$77.70	$67,754
21	Remove 4.5' x 4.46' TRAP	FT	89	$80.65	$7,178
22	Traffic Control	LS	1	$129,600	$129,600
23	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
24	Mobilization (10%)	LS	1	$523,000	$523,000
25	Miscellaneous Items (10%)	LS	1	$575,300	$575,300
	SUBTOTAL (CONSTRUCTION)				**$6,328,016**
26	Engineering and Design (8%)	LS	1	$506,300	$506,300
27	Surveying (1%)	LS	1	$63,300	$63,300
28	Construction Management (6%)	LS	1	$379,700	$379,700
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$949,300
	SUBTOTAL COST				$7,277,316
	CONTINGENCY			20%	$1,455,463
	TOTAL PROJECT				**$8,733,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Greenville Banning

Total Cost - SubArea 1

SubArea	Total Project Cost
1	$8,733,000
Total	**$8,733,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Greenville Banning, SUBAREA 2

Nodes 179 - 180

Street: Centennial

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	21	$288	$6,048
2	Install 60" RCP	FT	1033	$397	$410,101
3	Manhole	EA	0	$4,700	$0
4	Catch Basin	EA	0	$5,000	$0
5	Junction Structure	EA	0	$2,000	$0
6	Utility Relocation Allowance	LS	1	$83,300	$83,300
7	Remove 24" RCP	FT	4	$28.50	$114
8	Remove 30" RCP	FT	100	$31.05	$3,105
9	Remove 42" RCP	FT	950	$47.40	$45,030
10	Traffic Control	LS	1	$13,900	$13,900
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
12	Mobilization (10%)	LS	1	$56,700	$56,700
13	Miscellaneous Items (10%)	LS	1	$62,400	$62,400
SUBTOTAL (CONSTRUCTION)					**$685,698**
14	Engineering and Design (8%)	LS	1	$54,900	$54,900
15	Surveying (1%)	LS	1	$6,900	$6,900
16	Construction Management (6%)	LS	1	$41,200	$41,200
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$103,000
SUBTOTAL COST					$788,698
CONTINGENCY				20%	$157,740
TOTAL PROJECT					**$946,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Greenville Banning, SUBAREA 3
Nodes 186 - 187
Street: Sullivan

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 60" RCP	FT	278	$397	$110,366
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$22,100	$22,100
6	Remove 18" RCP	FT	36	$24.15	$869
7	Remove 24" RCP	FT	118	$28.50	$3,363
8	Remove 42" RCP	FT	124	$47.40	$5,878
9	Traffic Control	LS	1	$3,500	$3,500
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$15,200	$15,200
12	Miscellaneous Items (10%)	LS	1	$16,700	$16,700
	SUBTOTAL (CONSTRUCTION)				**$182,976**
13	Engineering and Design (8%)	LS	1	$14,700	$14,700
14	Surveying (1%)	LS	1	$1,900	$1,900
15	Construction Management (6%)	LS	1	$11,000	$11,000
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$27,600
	SUBTOTAL COST				$210,576
	CONTINGENCY			20%	$42,115
	TOTAL PROJECT				**$253,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Greenville Banning, SUBAREA 6
Nodes 179 - 180
Street: Centennial

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 39" RCP	FT	84	$263	$22,050
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$4,500	$4,500
6	Remove 21" RCP	FT	84	$26.33	$2,211
7	Traffic Control	LS	1	$800	$800
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$3,500	$3,500
10	Miscellaneous Items (10%)	LS	1	$3,900	$3,900
	SUBTOTAL (CONSTRUCTION)				**$41,961**
11	Engineering and Design (8%)	LS	1	$3,400	$3,400
12	Surveying (1%)	LS	1	$500	$500
13	Construction Management (6%)	LS	1	$2,600	$2,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$6,500
	SUBTOTAL COST				$48,461
	CONTINGENCY			20%	$9,692
	TOTAL PROJECT				**$58,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Greenville Banning, SUBAREA 7
Nodes 216 - 227
Street: Fairview, Warner

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP	FT	63	$190	$11,970
2	Install 48" RCP*	FT	121	$334	$40,414
3	Manhole	EA	0	$4,700	$0
4	Catch Basin	EA	0	$5,000	$0
5	Junction Structure	EA	0	$2,000	$0
6	Utility Relocation Allowance	LS	1	$8,100	$8,100
7	Remove 12" RCP	FT	25	$16	$401.25
8	Remove 18" RCP	FT	38	$24	$918
9	Traffic Control	LS	1	$1,300	$1,300
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$5,700	$5,700
12	Miscellaneous Items (10%)	LS	1	$6,200	$6,200
	SUBTOTAL (CONSTRUCTION)				**$68,033**
13	Engineering and Design (8%)	LS	1	$5,500	$5,500
14	Surveying (1%)	LS	1	$700	$700
15	Construction Management (6%)	LS	1	$4,100	$4,100
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$10,300
	SUBTOTAL COST				$78,333
	CONTINGENCY			20%	$15,667
	TOTAL PROJECT				**$94,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Greenville Banning

Total Cost - SubAreas 2 - 7

SubArea	Total Project Cost
2	$946,000
3	$253,000
4	$0
5	$0
6	$58,000
7	$94,000
Total	**$1,351,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Greenville Banning, SUBAREA 8
Nodes 231 - 244
Street: Fairview, Segerstrom

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	575	$334	$192,050
2	Install 60" RCP	FT	738	$397	$292,986
3	Manhole	EA	4	$4,700	$18,800
4	Catch Basin	EA	2	$5,000	$10,000
5	Junction Structure	EA	2	$2,000	$4,000
6	Utility Relocation Allowance	LS	1	$103,600	$103,600
7	Remove 42" RCP	FT	575	$47	$27,255
8	Remove 51" RCP	FT	738	$51	$37,583
9	Traffic Control	LS	1	$17,500	$17,500
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$70,900	$70,900
12	Miscellaneous Items (10%)	LS	1	$78,000	$78,000
	SUBTOTAL (CONSTRUCTION)				**$857,674**
13	Engineering and Design (8%)	LS	1	$68,700	$68,700
14	Surveying (1%)	LS	1	$8,600	$8,600
15	Construction Management (6%)	LS	1	$51,500	$51,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$128,800
	SUBTOTAL COST				$986,474
	CONTINGENCY			20%	$197,295
	TOTAL PROJECT				**$1,184,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Greenville Banning, SUBAREA 18
Nodes 328 - 331
Street: North of MacArthur and Harbor Gateway

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	33	$334	$11,022
2	Install 66" RCP	FT	1737	$518	$899,766
3	Manhole	EA	5	$4,700	$23,500
4	Catch Basin	EA	3	$5,000	$15,000
5	Junction Structure	EA	3	$2,000	$6,000
6	Utility Relocation Allowance	LS	1	$191,100	$191,100
7	Remove 27" RCP	FT	33	$30	$983
8	Remove 48" RCP	FT	164	$50	$8,216
9	Remove 54" RCP	FT	142	$52	$7,349
10	Remove 57" RCP	FT	726	$56	$40,402
11	Remove 60" RCP	FT	705	$60	$41,983
12	Traffic Control	LS	1	$31,700	$31,700
13	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
14	Mobilization (10%)	LS	1	$128,300	$128,300
15	Miscellaneous Items (10%)	LS	1	$141,100	$141,100
SUBTOTAL (CONSTRUCTION)					**$1,551,420**
16	Engineering and Design (8%)	LS	1	$124,200	$124,200
17	Surveying (1%)	LS	1	$15,600	$15,600
18	Construction Management (6%)	LS	1	$93,100	$93,100
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$232,900
SUBTOTAL COST					$1,784,320
CONTINGENCY				20%	$356,864
TOTAL PROJECT					**$2,141,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Greenville Banning

Total Cost - SubAreas 8 - 10, 18, & 20

SubArea	Total Project Cost
8	$1,184,000
9	$0
10	$0
18	$2,141,000
20	$0
Total	**$3,325,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Greenville Banning, SUBAREA 12
Nodes 255 - 271
Street: Moore, Manitoba, Alton, Fairview

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	287	$288	$82,656
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$16,600	$16,600
6	Remove 24" RCP	FT	287	$28.50	$8,180
7	Traffic Control	LS	1	$2,800	$2,800
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$11,600	$11,600
10	Miscellaneous Items (10%)	LS	1	$12,700	$12,700
	SUBTOTAL (CONSTRUCTION)				**$139,536**
11	Engineering and Design (8%)	LS	1	$11,200	$11,200
12	Surveying (1%)	LS	1	$1,400	$1,400
13	Construction Management (6%)	LS	1	$8,400	$8,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$21,000
	SUBTOTAL COST				$160,536
	CONTINGENCY			20%	$32,107
	TOTAL PROJECT				**$193,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Greenville Banning, SUBAREA 13
Nodes 272 - 322
Street: Sunflower, Raitt, Greenville, Fairview

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 30" RCP	FT	28	$207	$5,796
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$1,200	$1,200
6	Remove 21" RCP	FT	28	$26	$737
7	Traffic Control	LS	1	$200	$200
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$1,300	$1,300
10	Miscellaneous Items (10%)	LS	1	$1,500	$1,500
	SUBTOTAL (CONSTRUCTION)				**$15,733**
11	Engineering and Design (8%)	LS	1	$1,300	$1,300
12	Surveying (1%)	LS	1	$200	$200
13	Construction Management (6%)	LS	1	$1,000	$1,000
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$2,500
	SUBTOTAL COST				$18,233
	CONTINGENCY			20%	$3,647
	TOTAL PROJECT				**$22,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Greenville Banning, SUBAREA 14
Nodes 291 - 295
Street: Fairview, MacArthur

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	66	$288	$19,008
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$3,900	$3,900
6	Remove 24" RCP	FT	66	$29	$1,881
7	Traffic Control	LS	1	$700	$700
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$3,100	$3,100
10	Miscellaneous Items (10%)	LS	1	$3,400	$3,400
	SUBTOTAL (CONSTRUCTION)				**$36,989**
11	Engineering and Design (8%)	LS	1	$3,000	$3,000
12	Surveying (1%)	LS	1	$400	$400
13	Construction Management (6%)	LS	1	$2,300	$2,300
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$5,700
	SUBTOTAL COST				$42,689
	CONTINGENCY			20%	$8,538
	TOTAL PROJECT				**$51,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Greenville Banning

Total Cost - SubAreas 11 - 17, & 19

SubArea	Total Project Cost
11	$0
12	$193,000
13	$22,000
14	$51,000
15	$0
16	$0
17	$0
19	$0
Total	**$266,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Greenville Banning

Total Cost - SubAreas 1 - 19

SubAreas	Total Project Cost
1	$8,733,000
2 - 7	$1,351,000
8 - 10, 18, & 20	$3,325,000
11 - 17 & 19	$266,000
Total	**$13,675,000**

LANE BARRANCA COST ESTIMATES

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca, SUBAREA 1
Nodes 103 - 115
Streets: Southern Pacific Railroad (between Hunter and McFadden)

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	300	$334	$100,200
2	Manhole	EA	1	$4,700	$4,700
3	Catch Basin	EA	1	$5,000	$5,000
4	Junction Structure	EA	1	$2,000	$2,000
5	Utility Relocation Allowance	LS	1	$22,400	$22,400
6	Remove 24" RCP	FT	300	$28.50	$8,550
7	Traffic Control	LS	1	$3,700	$3,700
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$15,200	$15,200
10	Miscellaneous Items (10%)	LS	1	$16,700	$16,700
	SUBTOTAL (CONSTRUCTION)				**$183,450**
11	Engineering and Design (8%)	LS	1	$14,700	$14,700
12	Surveying (1%)	LS	1	$1,900	$1,900
13	Construction Management (6%)	LS	1	$11,100	$11,100
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$27,700
	SUBTOTAL COST				$211,150
	CONTINGENCY			20%	$42,230
	TOTAL PROJECT				**$253,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca, SUBAREA 2
Nodes 110.5 - 115
Street: McFadden

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	412	$288	$118,656
2	Manhole	EA	1	$4,700	$4,700
3	Catch Basin	EA	1	$5,000	$5,000
4	Junction Structure	EA	1	$2,000	$2,000
5	Utility Relocation Allowance	LS	1	$26,100	$26,100
6	Remove 24" RCP	FT	412	$28.50	$11,742
7	Traffic Control	LS	1	$4,300	$4,300
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$17,800	$17,800
10	Miscellaneous Items (10%)	LS	1	$19,600	$19,600
	SUBTOTAL (CONSTRUCTION)				**$214,898**
11	Engineering and Design (8%)	LS	1	$17,200	$17,200
12	Surveying (1%)	LS	1	$2,200	$2,200
13	Construction Management (6%)	LS	1	$12,900	$12,900
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$32,300
	SUBTOTAL COST				$247,198
	CONTINGENCY			20%	$49,440
	TOTAL PROJECT				**$297,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Lane Barranca, SUBAREA 3
Nodes 117 - 150.5
Street: Grand, Edinger

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	92	$288	$26,496
2	Install 42" RCP*	FT	766	$316	$242,056
3	Manhole	EA	2	$4,700	$9,400
4	Catch Basin	EA	1	$5,000	$5,000
5	Junction Structure	EA	1	$2,000	$2,000
6	Utility Relocation Allowance	LS	1	$57,000	$57,000
7	Remove 24" RCP	FT	92	$28.50	$2,622
8	Remove 36" RCP	FT	766	$43.20	$33,091
9	Traffic Control	LS	1	$9,700	$9,700
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$39,300	$39,300
12	Miscellaneous Items (10%)	LS	1	$43,200	$43,200
SUBTOTAL (CONSTRUCTION)					**$474,865**
13	Engineering and Design (8%)	LS	1	$38,000	$38,000
14	Surveying (1%)	LS	1	$4,800	$4,800
15	Construction Management (6%)	LS	1	$28,500	$28,500
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$71,300
SUBTOTAL COST					$546,165
CONTINGENCY				20%	$109,233
TOTAL PROJECT					**$655,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca, SUBAREA 5

Nodes 150.5 - 218

Street: Southern Pacific Railroad (between Edinger and Warner), Grand, Warner

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 42" RCP	FT	1013	$288	$291,744
2	Install 48" RCP	FT	60	$334	$20,040
3	Install 54" RCP	FT	236	$345	$81,420
4	Install 8'x6' RCB	FT	631	$615	$388,065
5	Install 8'x8' RCB	FT	1873	$1,840	$3,446,320
6	Manhole	EA	12	$4,700	$56,400
7	Catch Basin	EA	7	$5,000	$35,000
8	Junction Structure	EA	7	$2,000	$14,000
9	Utility Relocation Allowance	LS	1	$866,600	$866,600
10	Remove 12" RCP	FT	236	$16.05	$3,788
11	Remove 30" RCP	FT	1013	$31.05	$31,454
12	Remove 36" RCP	FT	60	$43.20	$2,592
13	Remove 6'x6' RCB	FT	631	$84.60	$53,383
14	Remove 8'x6.25' RCB	FT	667	$92.25	$61,531
15	Remove 7'x6' RCB	FT	1206	$80.70	$97,324
16	Traffic Control	LS	1	$137,500	$137,500
17	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
18	Mobilization (10%)	LS	1	$559,300	$559,300
19	Miscellaneous Items (10%)	LS	1	$615,200	$615,200
	SUBTOTAL (CONSTRUCTION)				**$6,766,660**
20	Engineering and Design (8%)	LS	1	$541,400	$541,400
21	Surveying (1%)	LS	1	$67,700	$67,700
22	Construction Management (6%)	LS	1	$406,000	$406,000
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$1,015,100
	SUBTOTAL COST				$7,781,760
	CONTINGENCY			20%	$1,556,352
	TOTAL PROJECT				**$9,338,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Lane Barranca, SUBAREA 6
Nodes 189 - 217
Street: Lyon, St Andrew, Ritchey, Wright

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP*	FT	49	$288	$14,112
2	Install 60" RCP*	FT	76	$397	$30,172
3	Install 72" RCP	FT	810	$466	$377,460
4	Manhole	EA	2	$4,700	$9,400
5	Catch Basin	EA	1	$5,000	$5,000
6	Junction Structure	EA	1	$2,000	$2,000
7	Utility Relocation Allowance	LS	1	$84,900	$84,900
8	Remove 36" RCP	FT	810	$43.20	$34,992
9	Traffic Control	LS	1	$13,800	$13,800
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$56,300	$56,300
12	Miscellaneous Items (10%)	LS	1	$62,000	$62,000
	SUBTOTAL (CONSTRUCTION)				**$681,024**
13	Engineering and Design (8%)	LS	1	$54,500	$54,500
14	Surveying (1%)	LS	1	$6,900	$6,900
15	Construction Management (6%)	LS	1	$40,900	$40,900
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$102,300
	SUBTOTAL COST				$783,324
	CONTINGENCY			20%	$156,665
	TOTAL PROJECT				**$940,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca

Total Cost - SubArea 1 - 6

SubArea	Total Project Cost
1	$253,000
2	$297,000
3	$655,000
4	$0
5	$9,338,000
6	$940,000
Total	**$11,483,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca, SUBAREA 7
Nodes 219 - 226.5
Street: Grand

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 42" RCP	FT	231	$316	$72,996
2	Install 10'x10' RCB	FT	2374	$2,415	$5,733,210
3	Manhole	EA	8	$4,700	$37,600
4	Catch Basin	EA	5	$5,000	$25,000
5	Junction Structure	EA	5	$2,000	$10,000
6	Utility Relocation Allowance	LS	1	$1,175,800	$1,175,800
7	Remove 30" RCP	FT	231	$31	$7,173
8	Remove 8'x10' RCB	FT	2374	$328	$778,079
9	Traffic Control	LS	1	$200,000	$200,000
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$804,500	$804,500
12	Miscellaneous Items (10%)	LS	1	$885,000	$885,000
	SUBTOTAL (CONSTRUCTION)				**$9,734,357**
13	Engineering and Design (8%)	LS	1	$778,800	$778,800
14	Surveying (1%)	LS	1	$97,400	$97,400
15	Construction Management (6%)	LS	1	$584,100	$584,100
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$1,460,300
	SUBTOTAL COST				$11,194,657
	CONTINGENCY			20%	$2,238,931
	TOTAL PROJECT				**$13,434,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca, SUBAREA 10
Nodes 266 - 280
Streets: Between Flora and Dyer

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 72" RCP	FT	1350	$466	$629,100
2	Install 10'x10' RCB	FT	274	$2,415	$661,710
3	Manhole	EA	5	$4,700	$23,500
4	Catch Basin	EA	3	$5,000	$15,000
5	Junction Structure	EA	3	$2,000	$6,000
6	Utility Relocation Allowance	LS	1	$267,100	$267,100
7	Remove 36" RCP	FT	8	$43	$346
8	Remove 48" RCP	FT	1342	$50	$67,234
9	Remove 6'x8' RCB	FT	274	$92	$25,277
10	Traffic Control	LS	1	$40,100	$40,100
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
12	Mobilization (10%)	LS	1	$174,100	$174,100
13	Miscellaneous Items (10%)	LS	1	$191,500	$191,500
	SUBTOTAL (CONSTRUCTION)				**$2,105,966**
14	Engineering and Design (8%)	LS	1	$168,500	$168,500
15	Surveying (1%)	LS	1	$21,100	$21,100
16	Construction Management (6%)	LS	1	$126,400	$126,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$316,000
	SUBTOTAL COST				$2,421,966
	CONTINGENCY			20%	$484,393
	TOTAL PROJECT				**$2,906,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca

Total Cost - SubAreas 7 - 10

SubArea	Total Project Cost
7	$13,434,000
8	$0
9	$0
10	$2,906,000
Total	**$16,340,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca, SUBAREA 11
Nodes 281 - 283.5
Street: Sutter

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	34	$288	$9,792
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$2,000	$2,000
6	Remove 18" RCP	FT	34	$43	$1,469
7	Traffic Control	LS	1	$400	$400
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$1,900	$1,900
10	Miscellaneous Items (10%)	LS	1	$2,100	$2,100
	SUBTOTAL (CONSTRUCTION)				**$22,661**
1	Engineering and Design (8%)	LS	1	$1,900	$1,900
2	Surveying (1%)	LS	1	$300	$300
3	Construction Management (6%)	LS	1	$1,400	$1,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$3,600
	SUBTOTAL COST				$26,261
	CONTINGENCY			20%	$5,252
	TOTAL PROJECT				**$32,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Lane Barranca, SUBAREA 13
Nodes 292 - 293
Street: Southeast of the intersection between Columbine and Halladay

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 60" RCP	FT	874	$397	$346,978
2	Manhole	EA	2	$4,700	$9,400
3	Catch Basin	EA	1	$5,000	$5,000
4	Junction Structure	EA	1	$2,000	$2,000
5	Utility Relocation Allowance	LS	1	$72,700	$72,700
6	Remove 21" RCP	FT	131	$26	$3,449
7	Remove 42" RCP	FT	743	$47	$35,218
8	Traffic Control	LS	1	$11,100	$11,100
9	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
10	Mobilization (10%)	LS	1	$49,100	$49,100
11	Miscellaneous Items (10%)	LS	1	$54,000	$54,000
	SUBTOTAL (CONSTRUCTION)				**$593,945**
1	Engineering and Design (8%)	LS	1	$47,600	$47,600
2	Surveying (1%)	LS	1	$6,000	$6,000
3	Construction Management (6%)	LS	1	$35,700	$35,700
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$89,300
	SUBTOTAL COST				$683,245
	CONTINGENCY			20%	$136,649
	TOTAL PROJECT				**$820,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca, SUBAREA 14
Nodes 296 - 296.5
Street: Regency

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 60" RCP	FT	349	$397	$138,553
2	Manhole	EA	1	$4,700	$4,700
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$28,700	$28,700
6	Remove 36" RCP	FT	79	$43	$3,413
7	Remove 54" RCP	FT	270	$52	$13,973
8	Traffic Control	LS	1	$4,400	$4,400
9	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
10	Mobilization (10%)	LS	1	$19,900	$19,900
11	Miscellaneous Items (10%)	LS	1	$21,900	$21,900
	SUBTOTAL (CONSTRUCTION)				**$240,538**
1	Engineering and Design (8%)	LS	1	$19,300	$19,300
2	Surveying (1%)	LS	1	$2,500	$2,500
3	Construction Management (6%)	LS	1	$14,500	$14,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$36,300
	SUBTOTAL COST				$276,838
	CONTINGENCY			20%	$55,368
	TOTAL PROJECT				**$332,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca, SUBAREA 15
Nodes 300 - 332
Streets: Halladay, Dyer, Oak, Maple, Main, Columbine
Majestic, Imperial Promenade, Regency, MacArthur

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	289	$288	$83,232
2	Install 42" RCP	FT	134	$316	$42,344
3	Install 48" RCP	FT	20	$334	$6,680
4	Install 54" RCP	FT	976	$345	$336,720
5	Install 72" RCP	FT	488	$466	$227,408
6	Manhole	EA	6	$4,700	$28,200
7	Catch Basin	EA	3	$5,000	$15,000
8	Junction Structure	EA	3	$2,000	$6,000
9	Utility Relocation Allowance	LS	1	$149,200	$149,200
10	Remove 18" RCP	FT	383	$24	$9,249
11	Remove 24" RCP	FT	300	$29	$8,550
12	Remove 36" RCP	FT	957	$43	$41,342
13	Remove 42" RCP	FT	267	$47	$12,656
14	Traffic Control	LS	1	$24,600	$24,600
15	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
16	Mobilization (10%)	LS	1	$99,700	$99,700
17	Miscellaneous Items (10%)	LS	1	$109,600	$109,600
SUBTOTAL (CONSTRUCTION)					**$1,205,482**
18	Engineering and Design (8%)	LS	1	$96,500	$96,500
19	Surveying (1%)	LS	1	$12,100	$12,100
20	Construction Management (6%)	LS	1	$72,400	$72,400
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$181,000
SUBTOTAL COST					$1,386,482
CONTINGENCY				20%	$277,296
TOTAL PROJECT					**$1,664,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Lane Barranca

Total Cost - SubAreas 11 - 15

SubArea	Total Project Cost
11	$32,000
12	$0
13	$820,000
14	$332,000
15	$1,664,000
Total	**$2,848,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Lane Barranca

Total Cost - SubAreas 1 -15

SubAreas	Total Project Cost
1 - 6	$11,483,000
7 - 10	$16,340,000
11 - 15	$2,848,000
Total	**$30,671,000**

SANTA ANA COST ESTIMATES

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Ana

Total Cost - SubArea 1

SubArea	Total Project Cost
1	$0
Total	**$0**

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Ana

Total Cost - SubAreas 2 - 8

SubArea	Total Project Cost
2	$0
3	$0
4	$0
5	$0
6	$0
7	$0
8	$0
Total	**$0**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Ana, SUBAREA 9
Nodes 383 - 384
Street: Flower

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	64	$288	$18,432
2	Manhole	EA	0	$4,700	$0
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$3,700	$3,700
6	Remove 18" RCP	FT	64	$24	$1,546
7	Traffic Control	LS	1	$600	$600
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
9	Mobilization (10%)	LS	1	$3,000	$3,000
10	Miscellaneous Items (10%)	LS	1	$3,300	$3,300
	SUBTOTAL (CONSTRUCTION)				**$35,578**
11	Engineering and Design (8%)	LS	1	$2,900	$2,900
12	Surveying (1%)	LS	1	$400	$400
13	Construction Management (6%)	LS	1	$2,200	$2,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$5,500
	SUBTOTAL COST				$41,078
	CONTINGENCY			20%	$8,216
	TOTAL PROJECT				**$49,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Ana, SUBAREA 10
Nodes 387 - 397
Street: Bristol, Park

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP*	FT	797	$334	$266,198
2	Install 60" RCP*	FT	895	$397	$355,315
3	Install 42" RCP	FT	45	$316	$14,220
4	Install 66" RCP*	FT	869	$431	$374,539
5	Manhole	EA	5	$4,700	$23,500
6	Catch Basin	EA	3	$5,000	$15,000
7	Junction Structure	EA	3	$2,000	$6,000
8	Utility Relocation Allowance	LS	1	$211,000	$211,000
9	Remove 30" RCP	FT	45	$31	$1,397
10	Remove 48" RCP	FT	797	$50	$39,930
11	Remove 60" RCP	FT	895	$60	$53,297
12	Remove 66" RCP	FT	869	$65	$56,181
13	Traffic Control	LS	1	$36,200	$36,200
14	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
15	Mobilization (10%)	LS	1	$145,800	$145,800
16	Miscellaneous Items (10%)	LS	1	$160,400	$160,400
	SUBTOTAL (CONSTRUCTION)				**$1,763,977**
17	Engineering and Design (8%)	LS	1	$141,200	$141,200
18	Surveying (1%)	LS	1	$17,700	$17,700
19	Construction Management (6%)	LS	1	$105,900	$105,900
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$264,800
	SUBTOTAL COST				$2,028,777
	CONTINGENCY			20%	$405,755
	TOTAL PROJECT				**$2,435,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Ana, SUBAREA 13
Nodes 432 - 434
Street: Santa Clara, Flower

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 30" RCP	FT	12	$207	$2,484
2	Install 36" RCP	FT	32	$288	$9,216
3	Install 48" RCP	FT	97	$334	$32,398
4	Install 60" RCP	FT	1232	$397	$489,104
5	Manhole	EA	0	$4,700	$0
6	Catch Basin	EA	0	$5,000	$0
7	Junction Structure	EA	0	$2,000	$0
8	Utility Relocation Allowance	LS	1	$106,700	$106,700
9	Remove 18" RCP	FT	141	$24	$3,405
10	Remove 30" RCP	FT	1232	$31	$38,254
11	Traffic Control	LS	1	$17,300	$17,300
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
13	Mobilization (10%)	LS	1	$70,400	$70,400
14	Miscellaneous Items (10%)	LS	1	$77,500	$77,500
	SUBTOTAL (CONSTRUCTION)				**$851,761**
15	Engineering and Design (8%)	LS	1	$68,200	$68,200
16	Surveying (1%)	LS	1	$8,600	$8,600
17	Construction Management (6%)	LS	1	$51,200	$51,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$128,000
	SUBTOTAL COST				$979,761
	CONTINGENCY			20%	$195,952
	TOTAL PROJECT				**$1,176,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Ana

Total Cost - SubAreas 9, 10, 13, 18, & 19

SubArea	Total Project Cost
9	$49,000
10	$2,435,000
13	$1,176,000
18	$0
19	$0
Total	**$3,660,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Ana, SUBAREA 11
Nodes 409 - 422
Street: Fairview

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 30" RCP	FT	35	$207	$7,245
2	Install 36" RCP	FT	727	$288	$209,376
3	Install 48" RCP	FT	506	$334	$169,004
4	Install 51" RCP	FT	51	$340	$17,315
5	Install 72" RCP	FT	945	$466	$440,370
6	Manhole	EA	4	$4,700	$18,800
7	Catch Basin	EA	2	$5,000	$10,000
8	Junction Structure	EA	2	$2,000	$4,000
9	Utility Relocation Allowance	LS	1	$175,300	$175,300
10	Remove 18" RCP	FT	35	$24	$845
11	Remove 24" RCP	FT	671	$29	$19,124
12	Remove 30" RCP	FT	56	$31	$1,739
13	Remove 42" RCP	FT	506	$47	$23,984
14	Remove 51" RCP	FT	51	$51	$2,597
15	Remove 60" RCP	FT	945	$60	$56,275
16	Traffic Control	LS	1	$29,500	$29,500
17	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
18	Mobilization (10%)	LS	1	$119,100	$119,100
19	Miscellaneous Items (10%)	LS	1	$131,000	$131,000
	SUBTOTAL (CONSTRUCTION)				**$1,440,573**
20	Engineering and Design (8%)	LS	1	$115,300	$115,300
21	Surveying (1%)	LS	1	$14,500	$14,500
22	Construction Management (6%)	LS	1	$86,500	$86,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$216,300
	SUBTOTAL COST				$1,656,873
	CONTINGENCY			20%	$331,375
	TOTAL PROJECT				**$1,988,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Ana

Total Cost - SubAreas 11 & 12

SubArea	Total Project Cost
11	$1,988,000
12	$0
Total	**$1,988,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Ana, SUBAREA 14 (1 of 2)
Nodes 362 - 468
Street: Santiago, 17th St

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP*	FT	248	$288	$71,424
2	Install 48" RCP	FT	30	$334	$10,020
3	Install 54" RCP	FT	1377	$345	$475,065
4	Install 60" RCP	FT	3026	$397	$1,201,322
5	Manhole	EA	15	$4,700	$70,500
6	Catch Basin	EA	9	$5,000	$45,000
7	Junction Structure	EA	9	$2,000	$18,000
8	Utility Relocation Allowance	LS	1	$378,300	$378,300
9	Remove 18" RCP	FT	15	$24	$362
10	Remove 30" RCP	FT	15	$31	$466
11	Remove 36" RCP	FT	2617	$43	$113,054
12	Remove 39" RCP	FT	861	$45.30	$39,003
13	Remove 42" RCP	FT	432	$47.40	$20,477
14	Remove 48" RCP	FT	741	$50.10	$37,124
15	Traffic Control	LS	1	$63,100	$63,100
16	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
17	Mobilization (10%)	LS	1	$254,900	$254,900
18	Miscellaneous Items (10%)	LS	1	$280,400	$280,400
			SUBTOTAL (CONSTRUCTION)		**$3,083,518**
19	Engineering and Design (8%)	LS	1	$246,700	$246,700
20	Surveying (1%)	LS	1	$30,900	$30,900
21	Construction Management (6%)	LS	1	$185,100	$185,100
			SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)		$462,700
			SUBTOTAL COST		$3,546,218
			CONTINGENCY	20%	$709,244
			TOTAL PROJECT		**$4,255,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Ana

Total Cost - SubArea14 (1 of 2)

SubArea	Total Project Cost
14 (1 of 2)	$4,255,000
Total	**$4,255,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Ana, SUBAREA 14 (2 of 2)
Nodes 468 - 509
Street: Towner, 17th St

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	45	$288	$12,960
2	Install 48" RCP	FT	15	$334	$5,010
3	Install 60" RCP	FT	1180	$397	$468,460
4	Manhole	EA	4	$4,700	$18,800
5	Catch Basin	EA	2	$5,000	$10,000
6	Junction Structure	EA	2	$2,000	$4,000
7	Utility Relocation Allowance	LS	1	$103,900	$103,900
8	Remove 36" RCP	FT	1210	$43	$52,272
9	Traffic Control	LS	1	$17,200	$17,200
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$69,800	$69,800
12	Miscellaneous Items (10%)	LS	1	$76,800	$76,800
	SUBTOTAL (CONSTRUCTION)				**$844,202**
13	Engineering and Design (8%)	LS	1	$67,600	$67,600
14	Surveying (1%)	LS	1	$8,500	$8,500
15	Construction Management (6%)	LS	1	$50,700	$50,700
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$126,800
	SUBTOTAL COST				$971,002
	CONTINGENCY			20%	$194,200
	TOTAL PROJECT				**$1,165,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Ana, SUBAREA 15
Nodes 494 - 496
Street: 21st St

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 58.5"x36" Corrugated Metal Arch	FT	65	$345	$22,425
2	Install 59"x81" Corrugated Metal Arch	FT	721	$466	$335,986
3	Manhole	EA	0	$4,700	$0
4	Catch Basin	EA	0	$5,000	$0
5	Junction Structure	EA	0	$2,000	$0
6	Utility Relocation Allowance	LS	1	$71,700	$71,700
7	Remove 58"x36" Corrugated Metal Arch	FT	786	$52	$40,676
8	Traffic Control	LS	1	$10,800	$10,800
9	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
10	Mobilization (10%)	LS	1	$48,700	$48,700
11	Miscellaneous Items (10%)	LS	1	$53,600	$53,600
	SUBTOTAL (CONSTRUCTION)				**$588,887**
12	Engineering and Design (8%)	LS	1	$47,200	$47,200
13	Surveying (1%)	LS	1	$5,900	$5,900
14	Construction Management (6%)	LS	1	$35,400	$35,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$88,500
	SUBTOTAL COST				$677,387
	CONTINGENCY			20%	$135,477
	TOTAL PROJECT				**$813,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Ana

Total Cost - SubArea14 (2 of 2) & 15

SubArea	Total Project Cost
14 (2 of 2)	$1,165,000
15	$813,000
Total	**$1,978,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Ana, SUBAREA 16
Nodes 513 - 535
Street: Washington

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 30" RCP	FT	18	$207	$3,726
2	Install 42" RCP*	FT	237	$316	$74,892
3	Install 66" RCP	FT	15	$431	$6,465
4	Install 6' x 4' RCB	FT	2924	$431	$1,260,244
4	Manhole	EA	0	$4,700	$0
5	Catch Basin	EA	0	$5,000	$0
6	Junction Structure	EA	0	$2,000	$0
7	Utility Relocation Allowance	LS	1	$269,100	$269,100
8	Remove 18" RCP	FT	15	$24	$362
9	Remove 21" RCP	FT	18	$26	$474
10	Traffic Control	LS	1	$40,400	$40,400
11	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
12	Mobilization (10%)	LS	1	$166,100	$166,100
13	Miscellaneous Items (10%)	LS	1	$182,700	$182,700
	SUBTOTAL (CONSTRUCTION)				**$2,009,463**
14	Engineering and Design (8%)	LS	1	$160,800	$160,800
15	Surveying (1%)	LS	1	$20,100	$20,100
16	Construction Management (6%)	LS	1	$120,600	$120,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$301,500
	SUBTOTAL COST				$2,310,963
	CONTINGENCY			20%	$462,193
	TOTAL PROJECT				**$2,773,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Ana, SUBAREA 17
Nodes 540 - 541
Street: Civic Center

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP*	FT	901	$334	$300,934
2	Install 48" RCP	FT	15	$334	$5,010
3	Manhole	EA	3	$4,700	$14,100
4	Catch Basin	EA	1	$5,000	$5,000
5	Junction Structure	EA	1	$2,000	$2,000
6	Utility Relocation Allowance	LS	1	$65,500	$65,500
7	Remove 36" RCP	FT	15	$43	$648
8	Traffic Control	LS	1	$9,900	$9,900
9	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
10	Mobilization (10%)	LS	1	$40,900	$40,900
11	Miscellaneous Items (10%)	LS	1	$44,900	$44,900
			SUBTOTAL (CONSTRUCTION)		**$493,892**
1	Engineering and Design (8%)	LS	1	$39,600	$39,600
2	Surveying (1%)	LS	1	$5,000	$5,000
3	Construction Management (6%)	LS	1	$29,700	$29,700
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$74,300
			SUBTOTAL COST		$568,192
			CONTINGENCY	20%	$113,638
			TOTAL PROJECT		**$682,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Ana

Total Cost - SubArea 16, 17, & 20

SubArea	Total Project Cost
16	$2,773,000
17	$682,000
20	$0
Total	**$3,455,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Ana

Total Cost - SubAreas 1 - 20

SubAreas	Total Project Cost
1	$0
2 - 8	$0
9, 10, 13, 18, & 19	$3,660,000
11 & 12	$1,988,000
14 (1 of 2)	$4,255,000
14 (2 of 2) & 15	$1,978,000
16, 17, & 20	$3,455,000
Total	**$15,336,000**

SANTA FE GRAND COST ESTIMATES

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Grand, SUBAREA 1
Nodes 112 - 115
Streets: Cherry, Old Grand, Santa Clara

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 54" RCP	FT	791	$345	$272,895
2	Install 36" RCP	FT	24	$288	$6,912
3	Manhole	EA	2	$4,700	$9,400
4	Catch Basin	EA	1	$5,000	$5,000
5	Junction Structure	EA	1	$2,000	$2,000
6	Utility Relocation Allowance	LS	1	$59,300	$59,300
7	Remove 24" RCP	FT	24	$28.50	$684
8	Remove 27" RCP	FT	791	$31.05	$24,561
9	Traffic Control	LS	1	$9,700	$9,700
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$39,600	$39,600
12	Miscellaneous Items (10%)	LS	1	$43,600	$43,600
	SUBTOTAL (CONSTRUCTION)				**$478,652**
13	Engineering and Design (8%)	LS	1	$38,300	$38,300
14	Surveying (1%)	LS	1	$4,800	$4,800
15	Construction Management (6%)	LS	1	$28,800	$28,800
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$71,900
	SUBTOTAL COST				$550,552
	CONTINGENCY			20%	$110,110
	TOTAL PROJECT				**$661,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Grand, SUBAREA 2
Nodes 121 - 132
Street: Santa Clara, Brynwood, Lincoln

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP*	FT	124	$190	$23,560
2	Install 36" RCP	FT	978	$288	$281,664
3	Install 60" RCP	FT	1748	$397	$693,956
4	Manhole	EA	9	$4,700	$42,300
5	Catch Basin	EA	5	$5,000	$25,000
6	Junction Structure	EA	5	$2,000	$10,000
7	Utility Relocation Allowance	LS	1	$215,300	$215,300
8	Remove Triple 24" RCP	FT	317	$86	$27,104
9	Remove 24" RCP	FT	978	$47.40	$46,357
10	Remove 39" RCP	FT	812	$47.40	$38,489
11	Remove 48" RCP	FT	619	$50.10	$31,012
12	Traffic Control	LS	1	$36,600	$36,600
13	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
14	Mobilization (10%)	LS	1	$147,700	$147,700
15	Miscellaneous Items (10%)	LS	1	$162,500	$162,500
	SUBTOTAL (CONSTRUCTION)				**$1,786,541**
16	Engineering and Design (8%)	LS	1	$143,000	$143,000
17	Surveying (1%)	LS	1	$17,900	$17,900
18	Construction Management (6%)	LS	1	$107,200	$107,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$268,100
	SUBTOTAL COST				$2,054,641
	CONTINGENCY			20%	$410,928
	TOTAL PROJECT				**$2,466,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Grand, SUBAREA 3
Nodes 124 - 158
Street: Lincoln, 17th St

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	173	$288	$49,824
2	Install 72" RCP	FT	1531	$466	$713,446
3	Install 96" RCP	FT	2255	$615	$1,386,825
4	Manhole	EA	13	$4,700	$61,100
5	Catch Basin	EA	7	$5,000	$35,000
6	Junction Structure	EA	7	$2,000	$14,000
7	Utility Relocation Allowance	LS	1	$452,100	$452,100
8	Remove 12" RCP	FT	173	$24.15	$4,178
9	Remove 54" RCP	FT	197	$51.75	$10,195
10	Remove 57" RCP	FT	1334	$59.55	$79,440
11	Remove 66" RCP	FT	1089	$64.65	$70,404
12	Remove 72" RCP	FT	586	$69.90	$40,961
13	Remove 75" RCP	FT	580	$77.70	$45,066
14	Traffic Control	LS	1	$75,400	$75,400
15	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
16	Mobilization (10%)	LS	1	$304,300	$304,300
17	Miscellaneous Items (10%)	LS	1	$334,800	$334,800
			SUBTOTAL (CONSTRUCTION)		**$3,682,039**
18	Engineering and Design (8%)	LS	1	$294,600	$294,600
19	Surveying (1%)	LS	1	$36,900	$36,900
20	Construction Management (6%)	LS	1	$221,000	$221,000
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$552,500
			SUBTOTAL COST		$4,234,539
			CONTINGENCY	20%	$846,908
			TOTAL PROJECT		**$5,081,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Grand, SUBAREA 4
Nodes 133 -158
Street: 17th St

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 48" RCP	FT	428	$334	$142,952
2	Install 54" RCP	FT	121	$345	$41,745
3	Install 60" RCP	FT	945	$397	$375,165
4	Manhole	EA	4	$4,700	$18,800
5	Catch Basin	EA	2	$5,000	$10,000
6	Junction Structure	EA	2	$2,000	$4,000
7	Utility Relocation Allowance	LS	1	$118,600	$118,600
8	Remove 36" RCP	FT	1494	$43.20	$64,541
9	Traffic Control	LS	1	$19,800	$19,800
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$80,100	$80,100
12	Miscellaneous Items (10%)	LS	1	$88,100	$88,100
	SUBTOTAL (CONSTRUCTION)				**$968,803**
13	Engineering and Design (8%)	LS	1	$77,600	$77,600
14	Surveying (1%)	LS	1	$9,700	$9,700
15	Construction Management (6%)	LS	1	$58,200	$58,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$145,500
	SUBTOTAL COST				$1,114,303
	CONTINGENCY			20%	$222,861
	TOTAL PROJECT				**$1,337,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Fe Grand

Total Cost - SubAreas 1 - 4

SubArea	Total Project Cost
1	$661,000
2	$2,466,000
3	$5,081,000
4	$1,337,000
Total	**$9,545,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Grand, SUBAREA 5
Nodes 158 -169
Street: Grand, 4th

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 54" RCP	FT	66	$345	$22,770
2	Install 60" RCP	FT	918	$397	$364,446
3	Manhole	EA	3	$4,700	$14,100
4	Catch Basin	EA	1	$5,000	$5,000
5	Junction Structure	EA	1	$2,000	$2,000
6	Utility Relocation Allowance	LS	1	$81,700	$81,700
7	Remove 36" RCP	FT	713	$43	$30,802
8	Remove 42" RCP	FT	271	$47	$12,845
9	Traffic Control	LS	1	$13,600	$13,600
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$55,300	$55,300
12	Miscellaneous Items (10%)	LS	1	$60,800	$60,800
	SUBTOTAL (CONSTRUCTION)				**$668,363**
13	Engineering and Design (8%)	LS	1	$53,500	$53,500
14	Surveying (1%)	LS	1	$6,700	$6,700
15	Construction Management (6%)	LS	1	$40,200	$40,200
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$100,400
	SUBTOTAL COST				$768,763
	CONTINGENCY			20%	$153,753
	TOTAL PROJECT				**$923,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Grand, SUBAREA 6
Nodes 169 - 194
Street: Grand, Lyon

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 42" RCP	FT	1244	$316	$393,104
2	Install 48" RCP	FT	365	$334	$121,910
3	Install 8' x8' RCB	FT	2540	$1,840	$4,673,600
4	Manhole	EA	13	$4,700	$61,100
5	Catch Basin	EA	8	$5,000	$40,000
6	Junction Structure	EA	8	$2,000	$16,000
7	Utility Relocation Allowance	LS	1	$1,061,200	$1,061,200
8	Remove 30" RCP	FT	77	$31	$2,391
9	Remove 36" RCP	FT	1167	$43	$50,414
10	Remove 42" RCP	FT	365	$47	$17,301
11	Remove 90" RCP	FT	2540	$81	$204,978
12	Traffic Control	LS	1	$165,400	$165,400
13	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
14	Mobilization (10%)	LS	1	$681,300	$681,300
15	Miscellaneous Items (10%)	LS	1	$749,400	$749,400
SUBTOTAL (CONSTRUCTION)					**$8,243,098**
16	Engineering and Design (8%)	LS	1	$659,500	$659,500
17	Surveying (1%)	LS	1	$82,500	$82,500
18	Construction Management (6%)	LS	1	$494,600	$494,600
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$1,236,600
SUBTOTAL COST					$9,479,698
CONTINGENCY				20%	$1,895,940
TOTAL PROJECT					**$11,376,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Fe Grand

Total Cost - SubAreas 5 - 6

SubArea	Total Project Cost
5	$923,000
6	$11,376,000
Total	**$12,299,000**

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Fe Grand

Total Cost - SubAreas 1 - 6

SubAreas	Total Project Cost
1 - 4	$9,545,000
5 - 6	$12,299,000
Total	**$21,844,000**

SANTA FE TUSTIN COST ESTIMATES

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Tustin, SUBAREA 1 (1 of 2)
Nodes 200 - 216
Street: Fairhaven, Old Tustin, 17th

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP*	FT	266	$190	$50,540
2	Install 30" RCP	FT	133	$207	$27,531
3	Install 36" RCP	FT	45	$288	$12,960
4	Install 42" RCP	FT	151	$316	$47,716
5	Manhole	EA	1	$4,700	$4,700
6	Catch Basin	EA	1	$5,000	$5,000
7	Junction Structure	EA	1	$2,000	$2,000
8	Utility Relocation Allowance	LS	1	$30,100	$30,100
9	Remove 18" RCP	FT	133	$24	$3,212
10	Remove 24" RCP	FT	196	$28.50	$5,586
11	Traffic Control	LS	1	$4,800	$4,800
12	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
13	Mobilization (10%)	LS	1	$20,000	$20,000
14	Miscellaneous Items (10%)	LS	1	$22,000	$22,000
	SUBTOTAL (CONSTRUCTION)				**$241,145**
15	Engineering and Design (8%)	LS	1	$19,300	$19,300
16	Surveying (1%)	LS	1	$2,500	$2,500
17	Construction Management (6%)	LS	1	$14,500	$14,500
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$36,300
	SUBTOTAL COST				$277,445
	CONTINGENCY			20%	$55,489
	TOTAL PROJECT				**$333,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Fe Tustin

Total Cost - SubArea1 (1 of 2)

SubArea	Total Project Cost
1 (1 of 2)	$333,000
Total	**$333,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Tustin, SUBAREA 1 (2 of 2)
Nodes 216 - 241
Street: Williams, Woolsey, Fruit, 4th, Wright, Eastside, Elk, Main, Village

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP*	FT	235	$190	$44,650
2	Install 30" RCP*	FT	93	$207	$19,251
3	Install 30" RCP	FT	351	$207	$72,657
4	Install 36" RCP	FT	142	$288	$40,896
5	Install 42" RCP	FT	44	$316	$13,904
6	Install 48" RCP	FT	1434	$334	$478,956
7	Manhole	EA	7	$4,700	$32,900
8	Catch Basin	EA	4	$5,000	$20,000
9	Junction Structure	EA	4	$2,000	$8,000
10	Utility Relocation Allowance	LS	1	$146,300	$146,300
11	Remove 18" RCP	FT	383	$24.15	$9,249
12	Remove 24" RCP	FT	186	$28.50	$5,301
13	Remove 36" RCP	FT	442	$43.20	$19,094
14	Remove 42" RCP	FT	992	$47.40	$47,021
15	Traffic Control	LS	1	$24,400	$24,400
16	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
17	Mobilization (10%)	LS	1	$98,800	$98,800
18	Miscellaneous Items (10%)	LS	1	$108,700	$108,700
SUBTOTAL (CONSTRUCTION)					**$1,195,080**
19	Engineering and Design (8%)	LS	1	$95,700	$95,700
20	Surveying (1%)	LS	1	$12,000	$12,000
21	Construction Management (6%)	LS	1	$71,800	$71,800
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$179,500
SUBTOTAL COST					$1,374,580
CONTINGENCY				20%	$274,916
TOTAL PROJECT					**$1,649,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Tustin

Total Cost - SubArea1 (2 of 2)

SubArea	Total Project Cost
1 (2 of 2)	$1,649,000
Total	**$1,649,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Santa Fe Tustin, SUBAREA 2
Nodes 242 - 248
Street: Tustin

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP*	FT	409	$190	$77,710
2	Install 30" RCP*	FT	118	$207	$24,426
3	Install 36" RCP	FT	255	$288	$73,440
3	Install 48" RCP	FT	2950	$334	$985,300
4	Manhole	EA	12	$4,700	$56,400
5	Catch Basin	EA	7	$5,000	$35,000
6	Junction Structure	EA	7	$2,000	$14,000
7	Utility Relocation Allowance	LS	1	$253,300	$253,300
8	Remove 24" RCP	FT	255	$28.50	$7,268
9	Remove 33" RCP	FT	2186	$43	$94,435
10	Remove 36" RCP	FT	610	$43	$26,352
11	Remove 4' x 2' RCB	FT	154	$47	$7,300
12	Traffic Control	LS	1	$41,900	$41,900
13	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
14	Mobilization (10%)	LS	1	$170,200	$170,200
15	Miscellaneous Items (10%)	LS	1	$187,300	$187,300
	SUBTOTAL (CONSTRUCTION)				**$2,059,330**
16	Engineering and Design (8%)	LS	1	$164,800	$164,800
17	Surveying (1%)	LS	1	$20,600	$20,600
18	Construction Management (6%)	LS	1	$123,600	$123,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$309,000
	SUBTOTAL COST				$2,368,330
	CONTINGENCY			20%	$473,666
	TOTAL PROJECT				**$2,842,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Fe Tustin

Total Cost - SubArea 2

SubArea	Total Project Cost
2	$2,842,000
Total	**$2,842,000**

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Fe Tustin

Total Cost - SubArea 3

SubArea	Total Project Cost
3	$0
Total	**$0**

Master Plan of Storm Drainage for City of Santa Ana
Watershed Santa Fe Tustin

Total Cost - SubAreas 1 - 3

SubAreas	Total Project Cost
1 (1 of 2)	$333,000
1 (2 of 2)	$1,649,000
2	$2,842,000
3	$0
Total	**$4,824,000**

WINTERSBURG COST ESTIMATES

Master Plan of Storm Drainage for City of Santa Ana

Watershed Wintersburg, SUBAREA 1
Nodes 110 - 113
Streets: Creek

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP*	FT	55	$288	$15,840
2	Install 36" RCP	FT	94	$288	$27,072
3	Manhole	EA	0	$4,700	$0
4	Catch Basin	EA	0	$5,000	$0
5	Junction Structure	EA	0	$2,000	$0
6	Remove 18" RCP	FT	94	$24	$2,270
7	Utility Relocation Allowance	LS	1	$8,600	$8,600
8	Traffic Control	LS	1	$1,300	$1,300
9	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
10	Mobilization (10%)	LS	1	$6,100	$6,100
11	Miscellaneous Items (10%)	LS	1	$6,700	$6,700
	SUBTOTAL (CONSTRUCTION)				**$72,882**
12	Engineering and Design (8%)	LS	1	$5,900	$5,900
13	Surveying (1%)	LS	1	$800	$800
14	Construction Management (6%)	LS	1	$4,400	$4,400
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$11,100
	SUBTOTAL COST				$83,982
	CONTINGENCY			20%	$16,796
	TOTAL PROJECT				**$101,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Wintersburg

Total Cost - SubAreas 1 - 4, 9, 16, 17, & 19 - 21

SubArea	Total Project Cost
1	$101,000
2	$0
3	$0
4	$0
9	$0
16	$0
17	$0
19	$0
20	$0
21	$0
Total	**$101,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Wintersburg, SUBAREA 5
Nodes 151 - 152
Street: Harbor, Jackson, 5th, Harper, 1st, Figueroa

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 24" RCP*	FT	89	$190	$16,910
2	Install 36" RCP	FT	344	$288	$99,072
3	Install 42" RCP	FT	339	$316	$107,124
4	Install 60" RCP	FT	965	$397	$383,105
5	Install 72" RCP	FT	362	$466	$168,692
6	Manhole	EA	6	$4,700	$28,200
7	Catch Basin	EA	4	$5,000	$20,000
8	Junction Structure	EA	4	$2,000	$8,000
9	Utility Relocation Allowance	LS	1	$162,900	$162,900
10	Remove 18" RCP	FT	36	$24	$869
11	Remove 30" RCP	FT	647	$31	$20,089
12	Remove 36" RCP	FT	1327	$43	$57,326
13	Traffic Control	LS	1	$26,800	$26,800
14	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
15	Mobilization (10%)	LS	1	$108,800	$108,800
16	Miscellaneous Items (10%)	LS	1	$119,600	$119,600
SUBTOTAL (CONSTRUCTION)					**$1,315,578**
17	Engineering and Design (8%)	LS	1	$105,300	$105,300
18	Surveying (1%)	LS	1	$13,200	$13,200
19	Construction Management (6%)	LS	1	$79,000	$79,000
SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)					$197,500
SUBTOTAL COST					$1,513,078
CONTINGENCY				20%	$302,616
TOTAL PROJECT					**$1,816,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Wintersburg, SUBAREA 15
Nodes 404 - 414
Street: Common, 5th, Jenkins

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP	FT	63	$288	$18,144
2	Install 6' x 2' Rectangular Channel	FT	204	$334	$68,136
3	Install 54" RCP	FT	1668	$345	$575,460
4	Manhole	EA	6	$4,700	$28,200
5	Catch Basin	EA	3	$5,000	$15,000
6	Junction Structure	EA	3	$2,000	$6,000
7	Utility Relocation Allowance	LS	1	$142,200	$142,200
8	Remove 18" RCP	FT	63	$24	$1,521
9	Remove 33" RCP	FT	1470	$38	$55,787
10	Remove 36" RCP	FT	198	$43	$8,554
11	Remove 6'x0.67' Rectangular Channel	FT	204	$31	$6,334
12	Traffic Control	LS	1	$23,500	$23,500
13	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
14	Mobilization (10%)	LS	1	$95,400	$95,400
15	Miscellaneous Items (10%)	LS	1	$105,000	$105,000
	SUBTOTAL (CONSTRUCTION)				**$1,154,236**
16	Engineering and Design (8%)	LS	1	$92,400	$92,400
17	Surveying (1%)	LS	1	$11,600	$11,600
18	Construction Management (6%)	LS	1	$69,300	$69,300
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$173,300
	SUBTOTAL COST				$1,327,536
	CONTINGENCY			20%	$265,507
	TOTAL PROJECT				**$1,593,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Wintersburg

Total Cost - SubAreas 5, 7, 10, 15, 22, & 26

SubArea	Total Project Cost
5	$1,816,000
7	$0
10	$0
15	$1,593,000
22	$0
26	$0
Total	**$3,409,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Wintersburg, SUBAREA 8

Nodes 258 -273

Street: Northeast of McFadden and Toland

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 54" RCP	FT	624	$345	$215,280
2	Install 60" RCP	FT	160	$397	$63,520
3	Manhole	EA	2	$4,700	$9,400
4	Catch Basin	EA	1	$5,000	$5,000
5	Junction Structure	EA	1	$2,000	$2,000
6	Utility Relocation Allowance	LS	1	$59,100	$59,100
7	Remove 36" RCP	FT	123	$43	$5,314
8	Remove 48" RCP	FT	661	$50	$33,116
9	Traffic Control	LS	1	$8,900	$8,900
10	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
11	Mobilization (10%)	LS	1	$40,700	$40,700
12	Miscellaneous Items (10%)	LS	1	$44,800	$44,800
	SUBTOTAL (CONSTRUCTION)				**$492,130**
13	Engineering and Design (8%)	LS	1	$39,400	$39,400
14	Surveying (1%)	LS	1	$5,000	$5,000
15	Construction Management (6%)	LS	1	$29,600	$29,600
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$74,000
	SUBTOTAL COST				$566,130
	CONTINGENCY			20%	$113,226
	TOTAL PROJECT				**$679,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Wintersburg, SUBAREA 18
Nodes 429 - 432
Street: Newhope

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 36" RCP*	FT	511	$288	$147,168
2	Install 48" RCP	FT	135	$334	$45,090
3	Manhole	EA	1	$4,700	$4,700
4	Catch Basin	EA	1	$5,000	$5,000
5	Junction Structure	EA	1	$2,000	$2,000
6	Utility Relocation Allowance	LS	1	$40,800	$40,800
7	Remove 36" RCP	FT	135	$43	$5,832
8	Traffic Control	LS	1	$6,200	$6,200
9	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
10	Mobilization (10%)	LS	1	$26,200	$26,200
11	Miscellaneous Items (10%)	LS	1	$28,800	$28,800
	SUBTOTAL (CONSTRUCTION)				**$316,790**
12	Engineering and Design (8%)	LS	1	$25,400	$25,400
13	Surveying (1%)	LS	1	$3,200	$3,200
14	Construction Management (6%)	LS	1	$19,100	$19,100
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$47,700
	SUBTOTAL COST				$364,490
	CONTINGENCY			20%	$72,898
	TOTAL PROJECT				**$437,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana

Watershed Wintersburg, SUBAREA 32
Nodes 552 - 561
Street: McFadden, Harbor

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 42" RCP	FT	45	$316	$14,220.00
2	Manhole	EA	0	$4,700	$0.00
3	Catch Basin	EA	0	$5,000	$0.00
4	Junction Structure	EA	0	$2,000	$0.00
5	Utility Relocation Allowance	LS	1	$2,900	$2,900.00
6	Remove 18" RCP	FT	45	$24	$1,086.75
7	Traffic Control	LS	1	$500	$500.00
8	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000.00
9	Mobilization (10%)	LS	1	$2,400	$2,400.00
10	Miscellaneous Items (10%)	LS	1	$2,700	$2,700.00
	SUBTOTAL (CONSTRUCTION)				**$28,807**
11	Engineering and Design (8%)	LS	1	$2,400	$2,400
12	Surveying (1%)	LS	1	$300	$300
13	Construction Management (6%)	LS	1	$1,800	$1,800
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$4,500
	SUBTOTAL COST				$33,307
	CONTINGENCY			20%	$6,661
	TOTAL PROJECT				**$40,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Wintersburg

Total Cost - SubAreas 6, 8, 18, 31, & 32

SubArea	Total Project Cost
6	$0
8	$679,000
18	$437,000
31	$0
32	$40,000
Total	**$1,156,000**

Master Plan of Storm Drainage for City of Santa Ana

Watershed Wintersburg, SUBAREA 14
Nodes 363 - 366
Street: Highland, Sail

REPLACEMENT COST ESTIMATE

Item No.	Item Description	PROJECT TOTAL			
		Unit of Measure	Estimated Quantities	Unit Price	Item Total
1	Install 42" RCP	FT	489	$316	$154,524
2	Manhole	EA	1	$4,700	$4,700
3	Catch Basin	EA	0	$5,000	$0
4	Junction Structure	EA	0	$2,000	$0
5	Utility Relocation Allowance	LS	1	$31,900	$31,900
6	Remove 27" RCP	FT	351	$31	$10,899
7	Remove 33" RCP	FT	138	$43	$5,962
8	Traffic Control	LS	1	$5,300	$5,300
9	Prepare Storm Water Pollution Prevention Plan	LS	1	$5,000	$5,000
10	Mobilization (10%)	LS	1	$21,900	$21,900
11	Miscellaneous Items (10%)	LS	1	$24,100	$24,100
	SUBTOTAL (CONSTRUCTION)				**$264,284**
12	Engineering and Design (8%)	LS	1	$21,200	$21,200
13	Surveying (1%)	LS	1	$2,700	$2,700
14	Construction Management (6%)	LS	1	$15,900	$15,900
	SUBTOTAL (ENGINEERING AND CONSTRUCTION ADMINISTRATION)				$39,800
	SUBTOTAL COST				$304,084
	CONTINGENCY			20%	$60,817
	TOTAL PROJECT				**$365,000**

*New Storm Drain

Master Plan of Storm Drainage for City of Santa Ana
Watershed Wintersburg

Total Cost - SubAreas 11-14, 23-25, 27-30

SubArea	Total Project Cost
11	$0
12	$0
13	$0
14	$365,000
23	$0
24	$0
25	$0
27	$0
28	$0
29	$0
30	$0
Total	**$365,000**

Master Plan of Storm Drainage for City of Santa Ana
Watershed Wintersburg

Total Cost - SubAreas 1 - 30

SubAreas	Total Project Cost
1 - 4, 9, 16, 17, 19 - 21	$101,000
5, 7, 10, 15, 22, 26	$3,409,000
6, 8, 18, 31, 32	$1,156,000
11 - 14, 23 - 25, 27 - 30	$365,000
Total	**$5,031,000**

TECHNICAL APPENDIX D

XPSWMM Models

(Included in CD only)

TECHNICAL APPENDIX E

HECRAS Analysis Results

(Models included in CD)

DELHI HEC RAS RESULTS

HEC-RAS Plan: Plan01 River: SantaAna-Delhi Reach: Reach1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach1	3066.9	10-yr	1206.00	22.23	29.93		30.29	0.001461	4.83	249.81	44.02	0.36
Reach1	3066.9	100-yr	1407.00	22.23	30.52		30.92	0.001502	5.09	276.45	45.80	0.37
Reach1	3066.9	100-yr HC	4000.00	22.23	36.44		36.90	0.001007	5.70	806.55	140.64	0.32
Reach1	3066.9	10-yr HC	2300.00	22.23	32.73		33.28	0.001617	5.97	385.25	59.67	0.39
Reach1	2587.9	10-yr	1206.00	21.92	29.10		29.52	0.001765	5.18	232.73	42.21	0.39
Reach1	2587.9	100-yr	1407.00	21.92	29.66		30.12	0.001826	5.48	256.78	43.75	0.40
Reach1	2587.9	100-yr HC	4000.00	21.92	35.49		36.25	0.001750	7.00	585.13	85.94	0.41
Reach1	2587.9	10-yr HC	2300.00	21.92	31.76		32.42	0.001988	6.48	355.13	49.59	0.43
Reach1	2427.3	10-yr	1206.00	21.82	28.27		29.06	0.004175	7.16	168.52	36.22	0.58
Reach1	2427.3	100-yr	1407.00	21.82	28.78		29.66	0.004223	7.50	187.71	37.84	0.59
Reach1	2427.3	100-yr HC	4000.00	21.82	34.77		35.85	0.003005	8.37	488.02	83.04	0.53
Reach1	2427.3	10-yr HC	2300.00	21.82	30.80		31.92	0.004169	8.51	270.22	44.13	0.61
Reach1	2381.9	10-yr	1206.00	21.79	26.80	26.80	28.65	0.013232	10.90	110.67	30.02	1.00
Reach1	2381.9	100-yr	1407.00	21.79	27.25	27.25	29.23	0.012991	11.30	124.57	31.46	1.00
Reach1	2381.9	100-yr HC	4000.00	21.79	34.41		35.68	0.003905	9.06	455.35	97.29	0.60
Reach1	2381.9	10-yr HC	2300.00	21.79	29.92		31.62	0.007383	10.47	219.66	40.04	0.79
Reach1	2342.6	10-yr	1206.00	21.76	27.30	24.90	27.81	0.002599	5.72	210.84	38.11	0.43
Reach1	2342.6	100-yr	1407.00	21.76	27.92	25.24	28.48	0.002565	6.00	234.54	38.12	0.43
Reach1	2342.6	100-yr HC	4000.00	21.76	34.45	28.76	35.49	0.002593	8.18	501.22	75.12	0.43
Reach1	2342.6	10-yr HC	2300.00	21.76	30.42	26.60	31.18	0.002493	6.97	329.92	38.18	0.42
Reach1	2342		Culvert									
Reach1	2196.8	10-yr	1206.00	21.76	26.52		27.21	0.000663	6.66	181.00	38.01	0.54
Reach1	2196.8	100-yr	1407.00	21.76	27.09		27.84	0.000637	6.94	202.78	38.01	0.53
Reach1	2196.8	100-yr HC	4000.00	21.76	33.12		34.45	0.000556	9.26	432.03	38.02	0.48
Reach1	2196.8	10-yr HC	2300.00	21.76	29.40		30.37	0.000580	7.92	290.43	38.01	0.50
Reach1	2131.7	10-yr	1206.00	21.75	26.65		27.02	0.000320	4.89	246.50	50.96	0.39
Reach1	2131.7	100-yr	1407.00	21.75	27.24		27.64	0.000305	5.09	276.52	51.10	0.39
Reach1	2131.7	100-yr HC	4000.00	21.75	33.42		34.11	0.000243	6.70	597.10	57.53	0.35
Reach1	2131.7	10-yr HC	2300.00	21.75	29.60		30.12	0.000267	5.78	398.01	51.69	0.37
Reach1	2082.2	10-yr	1206.00	21.72	26.60		27.00	0.000350	5.07	237.74	49.00	0.41
Reach1	2082.2	100-yr	1407.00	21.72	27.19		27.62	0.000334	5.28	266.45	49.07	0.40
Reach1	2082.2	100-yr HC	4000.00	21.72	33.34		34.09	0.000272	6.99	572.50	50.56	0.37
Reach1	2082.2	10-yr HC	2300.00	21.72	29.54		30.10	0.000297	6.02	382.34	49.58	0.38
Reach1	1916.9	10-yr	1206.00	21.60	26.53		26.94	0.000354	5.13	234.88	48.21	0.41
Reach1	1916.9	100-yr	1407.00	21.60	27.12		27.56	0.000339	5.34	263.24	48.36	0.40
Reach1	1916.9	100-yr HC	4000.00	21.60	33.27		34.05	0.000276	7.06	572.33	76.14	0.37
Reach1	1916.9	10-yr HC	2300.00	21.60	29.47		30.05	0.000302	6.09	377.80	48.97	0.39
Reach1	1730.4	10-yr	1206.00	21.47	26.50		26.87	0.000308	4.85	248.89	49.63	0.38
Reach1	1730.4	100-yr	1407.00	21.47	27.09		27.49	0.000297	5.06	278.23	49.67	0.38
Reach1	1730.4	100-yr HC	4000.00	21.47	33.26		33.98	0.000257	6.83	586.32	60.63	0.35
Reach1	1730.4	10-yr HC	2300.00	21.47	29.46		29.98	0.000271	5.81	395.81	49.84	0.36
Reach1	1487.7	10-yr	1206.00	21.30	26.43		26.79	0.000302	4.85	248.59	49.03	0.38
Reach1	1487.7	100-yr	1407.00	21.30	27.02		27.42	0.000292	5.07	277.69	49.15	0.38
Reach1	1487.7	100-yr HC	4000.00	21.30	33.19		33.92	0.000253	6.84	585.00	50.39	0.35
Reach1	1487.7	10-yr HC	2300.00	21.30	29.39		29.91	0.000268	5.83	394.61	49.63	0.36
Reach1	1247.5	10-yr	1206.00	21.14	26.39	23.75	26.71	0.000265	4.60	262.28	50.01	0.35
Reach1	1247.5	100-yr	1407.00	21.14	26.98	24.04	27.34	0.000259	4.82	292.05	50.01	0.35
Reach1	1247.5	100-yr HC	4000.00	21.14	33.16	26.96	33.85	0.000241	6.65	601.21	50.02	0.34
Reach1	1247.5	10-yr HC	2300.00	21.14	29.35	25.17	29.84	0.000245	5.60	410.75	50.01	0.34
Reach1	1247		Culvert									
Reach1	1184.1	10-yr	1206.00	21.09	26.11		26.46	0.000296	4.76	253.60	50.90	0.38
Reach1	1184.1	100-yr	1407.00	21.09	26.68		27.06	0.000287	4.98	282.67	50.98	0.37
Reach1	1184.1	100-yr HC	4000.00	21.09	32.60		33.32	0.000257	6.81	587.23	51.80	0.36
Reach1	1184.1	10-yr HC	2300.00	21.09	28.95		29.47	0.000268	5.76	399.02	51.30	0.36
Reach1	780.4	10-yr	1206.00	20.81	25.99		26.34	0.000287	4.76	253.47	49.48	0.37
Reach1	780.4	100-yr	1407.00	20.81	26.56		26.95	0.000281	4.99	281.76	49.60	0.37
Reach1	780.4	100-yr HC	4000.00	20.81	32.48		33.22	0.000259	6.91	578.86	50.84	0.36
Reach1	780.4	10-yr HC	2300.00	20.81	28.83		29.36	0.000269	5.82	395.03	50.07	0.37
Reach1	430.2	10-yr	1206.00	20.56	25.93	23.18	26.23	0.000232	4.40	274.04	52.19	0.34
Reach1	430.2	100-yr	1407.00	20.56	26.51	23.45	26.84	0.000229	4.63	304.13	52.43	0.34
Reach1	430.2	100-yr HC	4000.00	20.56	32.47	26.36	33.10	0.000215	6.41	623.96	54.95	0.34
Reach1	430.2	10-yr HC	2300.00	20.56	28.80	24.57	29.25	0.000221	5.41	425.22	53.40	0.34

HEC-RAS Plan: Plan01 River: SantaAna-Delhi Reach: Reach1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach1	430		Culvert									
Reach1	178.8	10-yr	1206.00	20.38	23.56	22.81	24.27	0.001000	6.76	178.34	56.07	0.67
Reach1	178.8	100-yr	1407.00	20.38	23.88	23.07	24.68	0.001002	7.17	196.32	56.07	0.68
Reach1	178.8	100-yr HC	4000.00	20.38	27.20	25.77	28.90	0.001001	10.45	382.66	56.14	0.71
Reach1	178.8	10-yr HC	2300.00	20.38	25.16	24.11	26.31	0.001000	8.58	268.01	56.10	0.69

GARDENS HEC RAS RESULTS

HEC-RAS Plan: Plan 01 River: GardensChannel Reach: GardensChannel Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
GardensChannel	24332.12	PF 1	820.00	71.27	78.26	77.07	79.70	0.011501	9.64	88.34	60.76	0.80
GardensChannel	23400	PF 1	820.00	69.46	76.53		76.69	0.001241	3.94	302.91	150.00	0.31
GardensChannel	23162.8	PF 1	820.00	67.90	76.02	72.78	76.34	0.001650	4.96	219.72	100.00	0.34
GardensChannel	23004.83		Culvert									
GardensChannel	22846.85	PF 1	820.00	62.42	73.01		73.38	0.001843	4.92	171.15	41.06	0.33
GardensChannel	22500	PF 1	820.00	62.44	72.91		73.03	0.000449	2.94	331.64	92.30	0.20
GardensChannel	22297.9	PF 1	820.00	61.99	72.64	67.65	72.88	0.001166	4.09	224.55	60.26	0.29
GardensChannel	22237.28		Culvert									
GardensChannel	22176.66	PF 1	820.00	60.74	70.22		70.56	0.001303	4.66	178.62	29.34	0.32
GardensChannel	21648.69	PF 1	820.00	60.13	69.74		69.96	0.000872	3.76	218.71	47.35	0.27
GardensChannel	21623.01	PF 1	820.00	60.10	69.73		69.94	0.000788	3.69	224.22	53.38	0.25
GardensChannel	21583.7	PF 1	820.00	60.32	69.42		69.87	0.002107	5.36	153.11	24.72	0.38
GardensChannel	21051.17	PF 1	820.00	58.61	68.41		68.81	0.001834	5.08	161.33	24.10	0.35
GardensChannel	20969.39	PF 1	820.00	58.76	68.29	63.86	68.64	0.001926	4.80	170.92	31.58	0.36
GardensChannel	20933.21		Culvert									
GardensChannel	20897.03	PF 1	820.00	57.79	66.99		67.62	0.003310	6.37	131.91	26.71	0.47
GardensChannel	20700	PF 1	820.00	57.66	66.86		67.14	0.001237	4.25	206.25	66.24	0.31
GardensChannel	19800	PF 1	820.00	56.76	65.71		65.97	0.001345	4.21	219.21	89.19	0.33
GardensChannel	19688.91	PF 1	820.00	56.05	65.55	61.30	65.81	0.001593	4.20	231.11	151.92	0.34
GardensChannel	19318.75		Culvert									
GardensChannel	18948.58	PF 1	820.00	53.36	61.17		62.58	0.009259	9.51	86.23	13.64	0.67
GardensChannel	18900	PF 1	820.00	53.03	61.42		62.08	0.003693	6.52	125.80	25.55	0.52
GardensChannel	18000	PF 1	820.00	50.57	59.04		59.46	0.002242	5.23	156.92	32.76	0.42
GardensChannel	17100	PF 1	820.00	48.26	57.22		57.60	0.001892	4.93	166.17	32.98	0.39
GardensChannel	16432.89	PF 1	820.00	47.38	55.80	52.97	56.22	0.002234	5.25	156.31	32.25	0.42
GardensChannel	16062.5		Culvert									
GardensChannel	15692.11	PF 1	820.00	45.93	54.08		54.69	0.003085	6.25	131.26	22.68	0.46
GardensChannel	15300	PF 1	820.00	45.63	52.89		53.45	0.003155	6.02	136.15	29.43	0.49
GardensChannel	15250.66	PF 1	820.00	44.86	52.84	49.81	53.29	0.002258	5.38	152.41	29.35	0.42
GardensChannel	15197.3		Culvert									
GardensChannel	15143.99	PF 1	820.00	43.86	52.25		52.61	0.001735	4.84	169.36	31.81	0.37
GardensChannel	15042.45	PF 1	820.00	43.52	52.00		52.42	0.002015	5.19	157.87	29.14	0.39
GardensChannel	14974.75	PF 1	820.00	43.68	51.90		52.27	0.001904	4.92	166.84	34.08	0.39
GardensChannel	14400	PF 1	820.00	42.58	51.09		51.36	0.001258	4.21	194.63	36.81	0.32
GardensChannel	14243.45	PF 1	820.00	42.02	50.83		51.15	0.001464	4.51	181.76	34.08	0.34
GardensChannel	14157.91	PF 1	820.00	42.14	50.51		50.97	0.002358	5.48	149.59	28.79	0.42
GardensChannel	14109.15	PF 1	820.00	42.20	50.37		50.85	0.002502	5.59	146.68	28.81	0.44
GardensChannel	14025.55	PF 1	820.00	42.13	50.31		50.64	0.001661	4.63	177.12	36.19	0.37
GardensChannel	13500	PF 1	820.00	41.22	49.44		49.77	0.001638	4.61	177.68	35.94	0.37
GardensChannel	12600	PF 1	820.00	39.84	46.44		47.27	0.005433	7.30	112.38	27.85	0.64
GardensChannel	11700	PF 1	820.00	34.94	42.94		43.51	0.003191	6.06	135.38	28.87	0.49
GardensChannel	11562.2	PF 1	820.00	34.56	42.61	40.02	43.09	0.002583	5.56	147.40	30.88	0.45
GardensChannel	11485.03		Culvert									
GardensChannel	11407.86	PF 1	820.00	34.54	41.13		41.89	0.004631	6.97	117.57	27.21	0.59
GardensChannel	10800	PF 1	820.00	30.81	39.25		39.74	0.002616	5.60	146.50	30.46	0.45
GardensChannel	10043.8	PF 1	820.00	28.97	37.68		38.05	0.001849	4.85	168.96	34.26	0.39
GardensChannel	9963.396	PF 1	820.00	27.62	37.63	32.70	37.91	0.001076	4.23	193.85	27.89	0.28
GardensChannel	9918.41		Culvert									
GardensChannel	9873.423	PF 1	820.00	28.36	35.86		36.34	0.002476	5.54	148.07	28.73	0.43
GardensChannel	9000	PF 1	820.00	25.91	34.63		34.88	0.001110	3.97	206.56	39.40	0.31
GardensChannel	8317.15	PF 1	820.00	25.29	34.09	29.23	34.28	0.000668	3.47	236.56	34.81	0.23
GardensChannel	8262.245		Culvert									
GardensChannel	8207.341	PF 1	820.00	25.70	33.52		34.03	0.002528	5.71	143.55	25.74	0.43
GardensChannel	8100	PF 1	820.00	25.70	33.60		33.79	0.000814	3.51	233.46	42.91	0.27
GardensChannel	7772.606	PF 1	820.00	26.04	33.19		33.45	0.001268	4.13	198.35	39.98	0.33
GardensChannel	7200	PF 1	820.00	25.65	32.31		32.63	0.001614	4.54	180.71	37.53	0.36
GardensChannel	6775.726	PF 1	820.00	24.53	31.12	29.04	31.67	0.003257	5.94	137.99	32.19	0.51
GardensChannel	6692.94		Culvert									
GardensChannel	6610.154	PF 1	820.00	24.67	28.67	28.56	30.39	0.002689	10.52	77.98	21.03	0.96
GardensChannel	6300	PF 1	820.00	24.98	28.65		29.56	0.001400	7.61	107.69	30.86	0.72
GardensChannel	5777.619	PF 1	820.00	24.00	28.52	26.75	28.98	0.000566	5.48	149.51	34.66	0.47
GardensChannel	5129.97		Culvert									
GardensChannel	4482.312	PF 1	820.00	23.40	27.61		28.12	0.000715	5.75	142.51	37.16	0.52
GardensChannel	3600	PF 1	820.00	22.45	27.18		27.59	0.000461	5.15	159.26	34.90	0.42
GardensChannel	2785.424	PF 1	820.00	21.64	25.19	25.19	26.72	0.002770	9.91	82.71	27.47	1.01
GardensChannel	1663.19		Culvert									
GardensChannel	540.9474	PF 1	820.00	18.31	24.12		24.18	0.000049	2.03	404.74	70.50	0.15
GardensChannel	465.684	PF 1	820.00	18.30	24.08		24.17	0.000070	2.39	343.66	60.52	0.18
GardensChannel	122.9115	PF 1	820.00	19.53	23.43	22.27	24.06	0.000900	6.39	128.39	34.60	0.58

GREENVILLE BANNING HEC RAS RESULTS

HEC-RAS Plan: Ex01 River: Greenville Reach: Greenville

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Greenville	11811.56	10	150.00	44.40	47.69		48.16	0.005083	5.51	27.23	10.15	0.59
Greenville	11811.56	50	300.00	44.40	48.96		49.79	0.006683	7.31	41.02	11.60	0.69
Greenville	11811.56	100	850.00	44.40	51.92	51.92	53.22	0.007411	9.45	101.08	43.59	0.76
Greenville	11811.56	500	2500.00	44.40	56.55		57.30	0.002140	7.89	373.20	59.66	0.46
Greenville	11580.84	10	150.00	43.81	47.20		47.39	0.001957	3.57	42.04	18.47	0.42
Greenville	11580.84	50	300.00	43.81	48.63		48.90	0.001814	4.16	72.19	23.59	0.42
Greenville	11580.84	100	850.00	43.81	51.93		52.31	0.001338	4.95	177.59	41.58	0.39
Greenville	11580.84	500	2500.00	43.81	56.24		56.91	0.001214	6.85	405.77	58.57	0.41
Greenville	11341.86	10	150.00	43.44	46.70		46.91	0.002072	3.69	40.65	17.44	0.43
Greenville	11341.86	50	300.00	43.44	48.16		48.45	0.001933	4.33	69.31	21.88	0.43
Greenville	11341.86	100	850.00	43.44	51.60		51.99	0.001330	5.08	175.59	38.39	0.38
Greenville	11341.86	500	2500.00	43.44	55.74		56.57	0.001581	7.58	360.34	51.85	0.45
Greenville	11115.48	10	150.00	43.11	46.14		46.38	0.002621	3.96	37.91	17.79	0.48
Greenville	11115.48	50	300.00	43.11	47.73		48.01	0.001926	4.26	70.40	23.12	0.43
Greenville	11115.48	100	850.00	43.11	51.35		51.69	0.001158	4.75	185.42	39.78	0.36
Greenville	11115.48	500	2500.00	43.11	55.43		56.23	0.001332	7.37	369.32	48.04	0.43
Greenville	10821.44	10	150.00	42.37	45.50		45.70	0.002015	3.59	41.81	18.70	0.42
Greenville	10821.44	50	300.00	42.37	47.31		47.53	0.001305	3.69	81.35	24.78	0.36
Greenville	10821.44	100	850.00	42.37	51.13		51.39	0.000799	4.17	212.17	41.04	0.31
Greenville	10821.44	500	2500.00	42.37	55.15		55.84	0.001090	6.85	394.11	45.95	0.39
Greenville	10779.18	10	150.00	42.22	45.42		45.61	0.001873	3.49	42.93	18.89	0.41
Greenville	10779.18	50	300.00	42.22	47.27		47.47	0.001214	3.59	83.54	25.06	0.35
Greenville	10779.18	100	850.00	42.22	51.10		51.35	0.000755	4.09	216.55	41.24	0.30
Greenville	10779.18	500	2500.00	42.22	55.15		55.78	0.001073	6.54	406.67	48.81	0.38
Greenville	10743.65	10	150.00	42.11	45.36		45.54	0.001748	3.41	44.01	19.08	0.40
Greenville	10743.65	50	300.00	42.11	47.23		47.42	0.001139	3.51	85.50	25.31	0.34
Greenville	10743.65	100	850.00	42.11	51.08		51.32	0.000719	4.02	220.34	41.40	0.29
Greenville	10743.65	500	2500.00	42.11	55.13		55.73	0.001011	6.39	421.72	52.55	0.37
Greenville	10655.79	10	150.00	41.78	45.16		45.36	0.002659	3.52	42.56	19.17	0.42
Greenville	10655.79	50	300.00	41.78	47.12		47.31	0.001515	3.42	87.64	26.77	0.33
Greenville	10655.79	100	850.00	41.78	51.04		51.25	0.000854	3.74	238.74	48.99	0.27
Greenville	10655.79	500	2500.00	41.78	55.13		55.61	0.001023	5.84	479.94	60.77	0.33
Greenville	10633.93	10	150.00	41.64	44.88	43.90	45.26	0.005316	4.92	30.47	12.22	0.55
Greenville	10633.93	50	300.00	41.64	46.81	45.05	47.23	0.003832	5.24	57.23	15.58	0.48
Greenville	10633.93	100	850.00	41.64	50.72	47.73	51.19	0.002428	5.73	168.87	52.78	0.41
Greenville	10633.93	500	2500.00	41.64	54.81	51.95	55.55	0.002178	7.63	384.65	52.78	0.42
Greenville	10600		Culvert									
Greenville	10568.53	10	150.00	41.13	44.52		44.80	0.003511	4.21	35.61	12.51	0.44
Greenville	10568.53	50	300.00	41.13	45.65		46.20	0.005346	5.94	50.51	13.86	0.55
Greenville	10568.53	100	850.00	41.13	47.85		49.45	0.010877	10.13	83.88	16.48	0.79
Greenville	10568.53	500	2500.00	41.13	52.08	52.08	54.42	0.009259	13.04	222.31	45.88	0.79
Greenville	10553.71	10	150.00	41.12	44.56		44.73	0.002280	3.28	45.69	20.63	0.39
Greenville	10553.71	50	300.00	41.12	45.81		46.06	0.002406	4.01	74.90	25.99	0.42
Greenville	10553.71	100	850.00	41.12	48.61		49.03	0.002342	5.17	164.35	37.79	0.44
Greenville	10553.71	500	2500.00	41.12	52.85		53.49	0.001727	6.67	418.27	72.04	0.41
Greenville	10428.91	10	150.00	40.66	43.89	43.19	44.26	0.006213	4.92	30.48	15.38	0.62
Greenville	10428.91	50	300.00	40.66	45.00		45.56	0.006657	6.02	49.85	19.47	0.66
Greenville	10428.91	100	850.00	40.66	47.74		48.56	0.005464	7.26	117.13	29.54	0.64
Greenville	10428.91	500	2500.00	40.66	52.49		53.22	0.002596	7.22	384.52	72.61	0.49
Greenville	10255.91	10	150.00	39.90	42.44		42.95	0.009295	5.73	26.19	14.35	0.75
Greenville	10255.91	50	300.00	39.90	43.79		44.39	0.006899	6.18	48.53	18.66	0.68
Greenville	10255.91	100	850.00	39.90	46.94		47.68	0.004544	6.91	122.93	28.66	0.59
Greenville	10255.91	500	2500.00	39.90	51.48		52.63	0.003850	8.65	298.40	63.08	0.59
Greenville	9983.434	10	150.00	39.20	42.18		42.25	0.000887	2.25	66.52	25.55	0.25
Greenville	9983.434	50	300.00	39.20	43.56		43.69	0.000957	2.88	103.99	28.39	0.27
Greenville	9983.434	100	850.00	39.20	46.70		46.98	0.001168	4.21	201.74	34.06	0.31
Greenville	9983.434	500	2500.00	39.20	51.15		51.81	0.001726	6.57	403.98	74.10	0.38
Greenville	9740.493	10	150.00	38.53	41.80		41.97	0.001506	3.27	45.89	18.62	0.37
Greenville	9740.493	50	300.00	38.53	43.11		43.37	0.001708	4.13	72.71	22.54	0.40
Greenville	9740.493	100	850.00	38.53	46.15		46.61	0.001768	5.47	155.53	31.92	0.44

HEC-RAS Plan: Ex01 River: Greenville Reach: Greenville (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Greenville	9740.493	500	2500.00	38.53	50.49		51.34	0.001941	7.52	353.84	68.21	0.49
Greenville	9484.005	10	150.00	37.76	41.02		41.36	0.003944	4.69	31.98	15.54	0.58
Greenville	9484.005	50	300.00	37.76	42.20		42.70	0.004123	5.68	52.79	19.75	0.61
Greenville	9484.005	100	850.00	37.76	45.44		46.05	0.002668	6.25	135.98	31.60	0.53
Greenville	9484.005	500	2500.00	37.76	49.95		50.82	0.002161	7.61	363.16	100.00	0.51
Greenville	8983.979	10	150.00	36.26	39.06		39.40	0.003910	4.63	32.36	16.05	0.58
Greenville	8983.979	50	300.00	36.26	40.49		40.90	0.003087	5.13	58.48	20.51	0.54
Greenville	8983.979	100	850.00	36.26	44.67		45.05	0.001367	4.95	171.73	33.75	0.39
Greenville	8983.979	500	2500.00	36.26	49.17		49.87	0.001498	6.81	397.22	100.00	0.43
Greenville	8729.203	10	150.00	35.50	38.31		38.56	0.002628	4.00	37.52	17.12	0.48
Greenville	8729.203	50	300.00	35.50	39.97		40.26	0.001897	4.32	69.47	21.58	0.42
Greenville	8729.203	100	850.00	35.50	44.44		44.74	0.000965	4.38	194.27	34.77	0.33
Greenville	8729.203	500	2500.00	35.50	49.05		49.52	0.000852	5.86	490.87	79.17	0.33
Greenville	8708.977	10	150.00	35.44	37.42	37.42	38.38	0.016576	7.89	19.02	9.95	1.01
Greenville	8708.977	50	300.00	35.44	38.58	38.56	40.05	0.016825	9.74	30.81	10.35	0.99
Greenville	8708.977	100	850.00	35.44	42.37	41.57	44.50	0.013749	11.72	72.51	11.77	0.83
Greenville	8708.977	500	2500.00	35.44	47.94	47.42	49.39	0.006440	10.94	281.91	58.33	0.60
Greenville	8650		Culvert									
Greenville	8597.227	10	150.00	35.10	36.98	36.89	37.76	0.013184	7.10	21.13	11.76	0.93
Greenville	8597.227	50	300.00	35.10	37.91	37.91	39.25	0.015221	9.27	32.38	12.27	1.00
Greenville	8597.227	100	850.00	35.10	40.60	40.60	43.08	0.016161	12.64	67.22	13.68	1.01
Greenville	8597.227	500	2500.00	35.10	46.61	46.61	48.13	0.006119	11.30	298.50	84.40	0.62
Greenville	8574.955	10	150.00	35.04	37.08		37.42	0.006526	4.70	31.94	18.72	0.63
Greenville	8574.955	50	300.00	35.04	38.08		38.59	0.006412	5.75	52.17	21.94	0.66
Greenville	8574.955	100	850.00	35.04	40.72		41.47	0.004961	6.99	121.54	30.73	0.62
Greenville	8574.955	500	2500.00	35.04	45.69		46.65	0.003271	7.88	317.34	48.43	0.54
Greenville	7983.966	10	150.00	32.62	34.97		35.17	0.002419	3.58	41.91	21.69	0.45
Greenville	7983.966	50	300.00	32.62	36.26		36.52	0.002076	4.15	72.34	25.83	0.44
Greenville	7983.966	100	850.00	32.62	39.47		39.85	0.001557	4.93	172.39	36.38	0.40
Greenville	7983.966	500	2500.00	32.62	44.84		45.40	0.001254	6.00	424.65	84.24	0.38
Greenville	7483.993	10	150.00	31.23	34.09		34.24	0.001432	3.09	48.57	21.21	0.36
Greenville	7483.993	50	300.00	31.23	35.44		35.66	0.001404	3.75	79.93	25.20	0.37
Greenville	7483.993	100	850.00	31.23	38.83		39.17	0.001170	4.66	182.50	35.42	0.36
Greenville	7483.993	500	2500.00	31.23	44.30		44.82	0.001033	5.85	444.88	86.86	0.36
Greenville	7412.441	10	150.00	31.19	33.96		34.12	0.001792	3.27	45.91	20.97	0.39
Greenville	7412.441	50	300.00	31.19	35.32		35.55	0.001691	3.88	77.39	25.34	0.39
Greenville	7412.441	100	850.00	31.19	38.74		39.08	0.001328	4.64	183.19	36.56	0.37
Greenville	7412.441	500	2500.00	31.19	44.24		44.74	0.001050	5.70	458.10	81.35	0.35
Greenville	6983.991	10	150.00	30.38	33.20		33.35	0.001818	3.08	48.67	22.40	0.37
Greenville	6983.991	50	300.00	30.38	34.65		34.85	0.001556	3.54	84.66	27.18	0.35
Greenville	6983.991	100	850.00	30.38	38.26		38.53	0.001145	4.16	204.18	39.06	0.32
Greenville	6983.991	500	2500.00	30.38	43.90		44.29	0.000917	5.08	527.44	96.29	0.31
Greenville	6590.479	10	150.00	29.40	32.46		32.61	0.001923	3.13	47.89	20.00	0.36
Greenville	6590.479	50	300.00	29.40	33.99		34.20	0.001732	3.66	82.04	24.70	0.35
Greenville	6590.479	100	850.00	29.40	37.76		38.05	0.001285	4.29	198.24	36.91	0.33
Greenville	6590.479	500	2500.00	29.40	43.48		43.90	0.001042	5.26	497.50	73.35	0.32
Greenville	6559.409	10	150.00	29.30	32.42		32.55	0.001489	2.96	50.60	20.92	0.34
Greenville	6559.409	50	300.00	29.30	33.96		34.14	0.001373	3.47	86.39	25.54	0.33
Greenville	6559.409	100	850.00	29.30	37.74		38.01	0.001089	4.16	204.47	36.92	0.31
Greenville	6559.409	500	2500.00	29.30	43.47		43.86	0.000923	5.10	524.28	82.30	0.30
Greenville	6403.939	10	150.00	28.92	32.04		32.25	0.002433	3.73	40.25	17.77	0.44
Greenville	6403.939	50	300.00	28.92	33.60		33.88	0.002073	4.19	71.54	22.21	0.41
Greenville	6403.939	100	850.00	28.92	37.46		37.80	0.001490	4.71	180.58	34.72	0.36
Greenville	6403.939	500	2500.00	28.92	43.25		43.70	0.001101	5.46	497.49	89.58	0.33
Greenville	6376.07	10	150.00	28.92	32.02	30.48	32.18	0.001633	3.28	45.77	16.55	0.35
Greenville	6376.07	50	300.00	28.92	33.55	31.37	33.82	0.001799	4.14	72.55	18.21	0.37
Greenville	6376.07	100	850.00	28.92	37.19	33.65	37.73	0.002251	5.89	144.19	21.17	0.40
Greenville	6376.07	500	2500.00	28.92	43.06	37.98	43.65	0.001504	6.81	458.79	80.15	0.34
Greenville	6300		Culvert									

HEC-RAS Plan: Ex01 River: Greenville Reach: Greenville (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Greenville	6271.208	10	150.00	28.48	32.02		32.11	0.000846	2.35	63.88	19.22	0.23
Greenville	6271.208	50	300.00	28.48	33.51		33.67	0.001129	3.22	93.21	20.20	0.26
Greenville	6271.208	100	850.00	28.48	36.80		37.18	0.001588	5.06	181.64	52.53	0.32
Greenville	6271.208	500	2500.00	28.48	42.84		43.11	0.000634	4.74	634.72	76.04	0.23
Greenville	6245.922	10	150.00	28.50	31.91		32.07	0.001659	3.21	46.80	19.47	0.36
Greenville	6245.922	50	300.00	28.50	33.41		33.63	0.001615	3.76	79.87	24.57	0.37
Greenville	6245.922	100	850.00	28.50	36.79		37.13	0.001478	4.67	182.07	35.87	0.37
Greenville	6245.922	500	2500.00	28.50	42.62		43.07	0.001047	5.43	484.23	75.00	0.33
Greenville	5983.972	10	150.00	28.30	31.42		31.60	0.001962	3.35	44.79	18.94	0.38
Greenville	5983.972	50	300.00	28.30	32.95		33.18	0.001799	3.89	77.09	23.41	0.38
Greenville	5983.972	100	850.00	28.30	36.35		36.72	0.001653	4.90	173.51	33.32	0.38
Greenville	5983.972	500	2500.00	28.30	42.38		42.78	0.001040	5.31	533.77	100.00	0.32
Greenville	5484.015	10	150.00	27.20	30.81		30.92	0.000950	2.59	57.95	20.66	0.27
Greenville	5484.015	50	300.00	27.20	32.31		32.47	0.001088	3.27	91.73	24.49	0.30
Greenville	5484.015	100	850.00	27.20	35.66		35.98	0.001285	4.48	189.67	34.22	0.34
Greenville	5484.015	500	2500.00	27.20	41.94		42.30	0.000842	4.98	565.32	100.00	0.29
Greenville	5250.36	10	150.00	27.00	30.57		30.67	0.001126	2.59	57.91	21.40	0.28
Greenville	5250.36	50	300.00	27.00	32.04		32.20	0.001233	3.24	92.48	25.66	0.30
Greenville	5250.36	100	850.00	27.00	35.37		35.67	0.001320	4.38	194.11	35.38	0.33
Greenville	5250.36	500	2500.00	27.00	41.73		42.10	0.000864	4.97	548.40	88.54	0.29
Greenville	4984	10	150.00	26.80	30.24		30.37	0.001180	2.79	53.70	20.90	0.31
Greenville	4984	50	300.00	26.80	31.68		31.86	0.001299	3.45	86.99	25.53	0.33
Greenville	4984	100	850.00	26.80	35.00		35.31	0.001320	4.48	189.53	36.14	0.35
Greenville	4984	500	2500.00	26.80	41.53		41.88	0.000741	4.87	568.64	100.00	0.28
Greenville	4529.84	10	150.00	25.90	28.72		29.25	0.006942	5.84	25.69	13.46	0.74
Greenville	4529.84	50	300.00	25.90	30.14		30.74	0.005623	6.25	48.03	18.12	0.68
Greenville	4529.84	100	850.00	25.90	33.84		34.42	0.002970	6.11	139.11	31.08	0.51
Greenville	4529.84	500	2500.00	25.90	41.06		41.50	0.000931	5.40	506.59	90.62	0.31
Greenville	4506.915	10	150.00	25.75	28.76	27.66	29.08	0.003383	4.48	33.48	12.86	0.49
Greenville	4506.915	50	300.00	25.75	30.08	28.71	30.61	0.004127	5.83	51.44	14.40	0.54
Greenville	4506.915	100	850.00	25.75	33.20	31.37	34.28	0.005261	8.34	101.90	17.84	0.62
Greenville	4506.915	500	2500.00	25.75	40.46	36.17	41.41	0.002760	8.31	363.18	80.86	0.46
Greenville	4450		Culvert									
Greenville	4396.556	10	150.00	25.68	28.84		28.99	0.001712	3.08	48.73	17.60	0.33
Greenville	4396.556	50	300.00	25.68	30.20		30.46	0.002075	4.06	73.87	19.39	0.37
Greenville	4396.556	100	850.00	25.68	33.30		33.87	0.002815	6.06	140.15	23.49	0.44
Greenville	4396.556	500	2500.00	25.68	38.44		39.66	0.003927	8.84	283.16	44.18	0.54
Greenville	4367.654	10	150.00	25.58	28.75		28.94	0.001843	3.44	43.60	19.21	0.40
Greenville	4367.654	50	300.00	25.58	30.15		30.40	0.001805	4.08	73.55	23.77	0.41
Greenville	4367.654	100	850.00	25.58	33.36		33.76	0.001653	5.07	167.63	34.96	0.41
Greenville	4367.654	500	2500.00	25.58	38.85		39.40	0.001286	5.99	433.26	83.73	0.38
Greenville	3983.963	10	150.00	24.83	28.17		28.31	0.001402	2.93	51.18	21.47	0.33
Greenville	3983.963	50	300.00	24.83	29.57		29.76	0.001459	3.54	84.68	26.53	0.35
Greenville	3983.963	100	850.00	24.83	32.85		33.15	0.001354	4.45	191.16	38.42	0.35
Greenville	3983.963	500	2500.00	24.83	38.58		38.94	0.000856	4.96	560.75	100.00	0.30
Greenville	3483.96	10	150.00	24.23	27.18		27.39	0.002469	3.67	40.84	19.20	0.44
Greenville	3483.96	50	300.00	24.23	28.60		28.87	0.002204	4.18	71.78	24.32	0.43
Greenville	3483.96	100	850.00	24.23	32.05		32.41	0.001631	4.80	177.20	36.75	0.38
Greenville	3483.96	500	2500.00	24.23	38.12		38.50	0.000901	5.07	545.65	100.00	0.31
Greenville	3234.654	10	150.00	23.61	26.64		26.82	0.002036	3.36	44.62	19.80	0.39
Greenville	3234.654	50	300.00	23.61	28.13		28.36	0.001819	3.86	77.71	24.75	0.38
Greenville	3234.654	100	850.00	23.61	31.70		32.02	0.001401	4.54	187.38	36.65	0.35
Greenville	3234.654	500	2500.00	23.61	37.92		38.28	0.000825	4.92	557.75	92.71	0.29
Greenville	3211.886	10	150.00	23.58	26.47	25.40	26.75	0.003347	4.27	35.09	14.27	0.48
Greenville	3211.886	50	300.00	23.58	27.84	26.38	28.28	0.003682	5.36	55.98	16.22	0.51
Greenville	3211.886	100	850.00	23.58	31.09	28.86	31.92	0.004180	7.30	116.47	21.16	0.55
Greenville	3211.886	500	2500.00	23.58	37.59	34.47	38.22	0.001821	6.78	420.31	75.70	0.40
Greenville	3150		Culvert									

HEC-RAS Plan: Ex01   River: Greenville   Reach: Greenville (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Greenville	3088.147	10	150.00	23.27	26.55		26.64	0.000894	2.35	63.88	21.86	0.24
Greenville	3088.147	50	300.00	23.27	27.92		28.07	0.001124	3.16	94.80	23.52	0.28
Greenville	3088.147	100	850.00	23.27	30.89		31.28	0.001735	4.99	170.42	27.61	0.35
Greenville	3088.147	500	2500.00	23.27	37.24		37.76	0.001270	6.03	460.37	64.14	0.32
Greenville	3063.294	10	150.00	23.20	26.42		26.60	0.002070	3.37	44.45	19.46	0.39
Greenville	3063.294	50	300.00	23.20	27.77		28.02	0.002118	4.08	73.58	23.86	0.41
Greenville	3063.294	100	850.00	23.20	30.80		31.23	0.002106	5.28	160.85	33.76	0.43
Greenville	3063.294	500	2500.00	23.20	37.27		37.71	0.001043	5.40	505.41	101.05	0.32
Greenville	2830.889	10	150.00	22.79	26.01		26.16	0.001638	3.14	47.77	19.84	0.36
Greenville	2830.889	50	300.00	22.79	27.32		27.56	0.001844	3.93	76.33	23.80	0.39
Greenville	2830.889	100	850.00	22.79	30.32		30.75	0.002009	5.27	161.33	32.86	0.42
Greenville	2830.889	500	2500.00	22.79	36.96		37.45	0.001145	5.59	453.15	70.63	0.34
Greenville	2767.556	10	150.00	22.79	25.92		26.06	0.001513	3.02	49.74	20.76	0.34
Greenville	2767.556	50	300.00	22.79	27.22		27.44	0.001697	3.78	79.34	24.78	0.37
Greenville	2767.556	100	850.00	22.79	30.22		30.62	0.001841	5.08	167.48	34.00	0.40
Greenville	2767.556	500	2500.00	22.79	36.94		37.36	0.000983	5.30	492.03	74.26	0.31
Greenville	2484.061	10	150.00	22.38	25.36		25.55	0.002189	3.41	43.97	20.16	0.41
Greenville	2484.061	50	300.00	22.38	26.60		26.88	0.002335	4.18	71.70	24.58	0.43
Greenville	2484.061	100	850.00	22.38	29.63		30.06	0.002111	5.23	162.54	35.41	0.43
Greenville	2484.061	500	2500.00	22.38	36.79		37.09	0.000703	4.58	603.17	100.00	0.27
Greenville	1984.057	10	150.00	21.51	24.08		24.30	0.002858	3.72	40.27	20.57	0.47
Greenville	1984.057	50	300.00	21.51	25.37		25.66	0.002539	4.29	69.92	25.39	0.46
Greenville	1984.057	100	850.00	21.51	28.72		29.09	0.001725	4.83	175.95	37.89	0.40
Greenville	1984.057	500	2500.00	21.51	36.56		36.79	0.000450	3.96	696.83	100.00	0.22
Greenville	1646.702	10	150.00	20.50	23.03		23.28	0.003143	4.03	37.21	18.41	0.50
Greenville	1646.702	50	300.00	20.50	24.50		24.81	0.002493	4.43	67.79	23.17	0.46
Greenville	1646.702	100	850.00	20.50	28.14		28.52	0.001654	4.89	173.94	35.20	0.39
Greenville	1646.702	500	2500.00	20.50	36.39		36.63	0.000489	4.09	668.30	100.00	0.23
Greenville	1623.631	10	150.00	20.43	23.00	21.97	23.21	0.002607	3.66	40.95	19.16	0.44
Greenville	1623.631	50	300.00	20.43	24.47	22.80	24.74	0.002154	4.17	71.96	22.84	0.41
Greenville	1623.631	100	850.00	20.43	28.10	24.87	28.48	0.001648	4.90	173.42	33.25	0.38
Greenville	1623.631	500	2500.00	20.43	36.30	28.55	36.61	0.000585	4.54	581.70	69.45	0.25
Greenville	1600		Culvert									
Greenville	1527.518	10	150.00	20.14	22.97		23.11	0.001515	3.02	49.72	21.05	0.35
Greenville	1527.518	50	300.00	20.14	24.39		24.60	0.001487	3.65	82.10	24.49	0.35
Greenville	1527.518	100	850.00	20.14	27.65		28.02	0.001530	4.88	174.00	31.91	0.37
Greenville	1527.518	500	2500.00	20.14	34.88		35.32	0.000841	5.34	487.53	62.16	0.29
Greenville	1484.057	10	150.00	20.01	22.92		23.04	0.001236	2.80	53.64	23.49	0.33
Greenville	1484.057	50	300.00	20.01	24.36		24.53	0.001140	3.30	90.99	28.51	0.33
Greenville	1484.057	100	850.00	20.01	27.67		27.93	0.001019	4.16	204.33	40.05	0.32
Greenville	1484.057	500	2500.00	20.01	34.97		35.24	0.000492	4.19	627.15	100.00	0.24
Greenville	1242.354	10	150.00	19.45	22.62		22.74	0.001291	2.76	54.35	22.81	0.32
Greenville	1242.354	50	300.00	19.45	24.07		24.24	0.001259	3.29	91.21	27.99	0.32
Greenville	1242.354	100	850.00	19.45	27.40		27.67	0.001162	4.16	204.29	39.89	0.32
Greenville	1242.354	500	2500.00	19.45	34.85		35.11	0.000519	4.12	641.15	117.23	0.23
Greenville	983.9269	10	150.00	18.87	22.30		22.41	0.001216	2.62	57.36	22.59	0.29
Greenville	983.9269	50	300.00	18.87	23.75		23.91	0.001258	3.21	93.45	27.35	0.31
Greenville	983.9269	100	850.00	18.87	27.09		27.36	0.001219	4.18	203.54	38.52	0.32
Greenville	983.9269	500	2500.00	18.87	34.71		34.97	0.000549	4.18	618.80	94.01	0.24
Greenville	720.4535	10	150.00	18.60	21.95		22.08	0.001282	2.84	52.90	21.52	0.32
Greenville	720.4535	50	300.00	18.60	23.38		23.57	0.001338	3.45	87.02	26.28	0.33
Greenville	720.4535	100	850.00	18.60	26.73		27.03	0.001273	4.39	193.81	37.44	0.34
Greenville	720.4535	500	2500.00	18.60	34.56		34.83	0.000531	4.20	621.31	93.69	0.24
Greenville	417.7325	10	150.00	18.41	21.39		21.57	0.002237	3.43	43.68	19.99	0.41
Greenville	417.7325	50	300.00	18.41	22.83		23.07	0.001980	3.94	76.23	25.05	0.40
Greenville	417.7325	100	850.00	18.41	26.27		26.61	0.001532	4.64	183.11	37.07	0.37
Greenville	417.7325	500	2500.00	18.41	34.40		34.67	0.000520	4.19	605.80	86.69	0.24
Greenville	387.9583	10	150.00	18.41	21.44	19.54	21.50	0.000571	2.01	74.58	27.96	0.22
Greenville	387.9583	50	300.00	18.41	22.90	20.19	23.00	0.000620	2.55	117.72	31.19	0.23
Greenville	387.9583	100	850.00	18.41	26.34	21.85	26.54	0.000715	3.57	238.22	38.95	0.25

HEC-RAS Plan: Ex01 River: Greenville Reach: Greenville (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Greenville	387.9583	500	2500.00	18.41	34.41	25.08	34.65	0.000456	3.96	639.94	83.93	0.21
Greenville	350		Culvert									
Greenville	337.1669	10	150.00	18.30	21.12		21.43	0.003542	4.41	34.04	13.56	0.49
Greenville	337.1669	50	300.00	18.30	22.32		22.86	0.004604	5.87	51.07	14.86	0.56
Greenville	337.1669	100	850.00	18.30	24.80		26.15	0.007792	9.32	91.21	17.55	0.72
Greenville	337.1669	500	2500.00	18.30	28.40	28.40	32.12	0.015178	15.47	161.64	21.76	1.00
Greenville	306.0611	10	150.00	18.23	21.12	19.95	21.30	0.002204	3.43	43.75	20.26	0.41
Greenville	306.0611	50	300.00	18.23	22.42	20.81	22.68	0.002201	4.12	72.87	24.68	0.42
Greenville	306.0611	100	850.00	18.23	25.31	22.83	25.76	0.002200	5.35	158.73	34.59	0.44
Greenville	306.0611	500	2500.00	18.23	29.99	26.30	30.75	0.002203	6.99	357.89	50.57	0.46

TECHNICAL APPENDIX F

Catch Basin Inflow Curves

(Included in CD only)

TECHNICAL APPENDIX G

Prioritization Calculations

DELHI PRIORITIZATION

Delhi Project Prioritization											
Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
DH1	Spurgeon St/Bush St between Washington and Santa Ana Blvd	1	1	$ 2,769,000	$ 2,769,000	1	0	3	2	26%	**26%**
DH2	Penn Way/Santiago St/Santa Ana Blvd	2	1	$ 3,139,000	$ 3,139,000	1	0	5	2	34%	**34%**
DH3	French St	4	1	$ 569,000	$ 569,000	4	5	5	1	68%	**47%**
		5	1	$ 333,000	$ 333,000	5	0	3	1	45%	
		7	1	$ 858,000	$ 858,000	3	0	5	1	43%	
		9	2	$ 65,000	$ 65,000	5	0	3	1	51%	
		10	2	$ 1,536,000	$ 1,536,000	2	0	3	2	37%	
DH4	Maple St	11	2	$ 863,000	$ 863,000	3	0	3	1	41%	**41%**
DH5	Maple St/ McFadden Ave	12	3	$ 7,817,000	$ 7,817,000	1	5	3	3	60%	**60%**
DH6	Maple St/ Hobart St	13	4	$ 2,369,000	$ 2,369,000	1	0	5	2	52%	**47%**
		14	3	$ 1,347,000	$ 1,347,000	2	0	1	2	35%	
		15	4	$ 3,062,000	$ 3,062,000	1	0	5	3	54%	
DH7	Rouselle St/Maple St	16	5	$ 5,622,000	$ 5,622,000	1	0	5	3	60%	**57%**
		17	5	$ 3,593,000	$ 3,593,000	1	0	5	3	60%	
		18	5	$ 2,402,000	$ 2,402,000	1	0	3	2	50%	

Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
DH8	Standard Ave/ Warner Ave	19	5	$ 5,199,000	$ 5,199,000	1	0	5	3	60%	**60%**
DH9	Civic Center Dr/ Ross St/ 3rd St	20	1	$ 1,597,000	$ 1,597,000	2	5	3	2	51%	**56%**
		21	2	$ 2,294,000	$ 2,294,000	1	5	5	2	60%	
DH10	Flower St/ Walnut St/ Parton St/ 1st St	22	2	$ 3,538,000	$ 3,538,000	1	0	5	3	42%	**42%**
DH11	Civic Center Dr/ Shelton St/ Pine St	23	2	$ 12,332,000	$12,332,000	1	0	3	3	34%	**34%**
DH12	Shelton St/ Richland Ave/ McFadden Ave/ Flower St	24	3	$ 56,000	$ 56,000	5	0	3	1	57%	**55%**
		25	3	$ 170,000	$ 170,000	5	5	5	1	85%	
		26	3	$ 8,753,000	$ 8,753,000	1	0	3	3	40%	
		27	3	$ 3,335,000	$ 3,335,000	1	0	3	3	40%	
DH13	Towner St/ Wilshire Ave/ Edinger Ave	28	4	$ 6,444,000	$ 6,444,000	1	0	3	3	46%	**50%**
		29	4	$ 9,598,000	$ 9,598,000	1	0	5	3	54%	
DH14	Main St/ Edinger Ave/ Flower St	30	4	$ 4,295,000	$ 4,295,000	1	0	5	3	54%	**53%**
		31	5	$ 7,001,000	$ 7,001,000	1	0	3	3	52%	
DH15	Flower St	32	5	$ 4,013,000	$ 4,013,000	1	0	3	3	52%	**51%**
		34	5	$ 2,782,000	$ 2,782,000	1	0	3	2	50%	
DH16	Warner Ave/ Orange Ave	33	5	$ 28,039,000	$28,039,000	1	0	5	3	60%	**60%**

Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
DH17	Bristol St/ Warner Ave/ Rosewood Ave/ Anahurst Pl	35	5	$ 6,494,000	$ 6,494,000	1	5	5	3	80%	**80%**
DH18	Central Ave	36	5	$ 389,000	$ 389,000	5	0	5	1	77%	**77%**
DH19	Hemlock Way/ Lowell St/ Ramona Dr/ Olive St	38	5	$ 4,221,000	$ 4,221,000	1	5	5	3	80%	**80%**
DH20	Union Pacific Railroad between Dyer Rd and Flower St	40	5	$ 1,756,000	$ 1,756,000	2	0	5	2	63%	**63%**
DH21	Bradford Pl/ Alton Ave/ Columbine Ave	41	5	$ 1,662,000	$ 1,662,000	2	0	5	2	63%	**69%**
		42	5	$ 100,000	$ 100,000	5	0	5	1	77%	
		44	5	$ 59,000	$ 59,000	5	0	5	1	77%	
DH22	Alpine Ave/ MacArthur Blvd	45	5	$ 177,000	$ 177,000	5	0	5	1	77%	**68%**
		46	5	$ 3,077,000	$ 3,077,000	1	0	5	3	60%	
DH23	MacArthur/ Woodland Pl	47	5	$ 188,000	$ 188,000	5	0	5	1	77%	**70%**
		48	5	$ 1,040,000	$ 1,040,000	2	0	5	2	63%	

GARDENS PRIORITIZATION

Gardens Project Prioritization											
Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
1	English St	1	1	$ 1,048,000	$ 1,048,000	2	5	5	2	59%	**59%**
2	Center St/ Edinger Ave	14	3	$ 2,120,000	$ 2,120,000	1	0	3	2	38%	**38%**
3	Raitt St/ Gardens Channel/ Glenwood Pl	18	3	$ 9,483,000	$ 9,483,000	1	0	5	3	48%	**53%**
		19	4	$ 1,609,000	$ 1,609,000	2	0	5	2	57%	
		20	4	$ 10,798,000	$10,798,000	1	0	5	3	54%	
4	Gertrude Pl	21	4	$ 135,000	$ 135,000	4	4	1	1	66%	**66%**
5	Gardens Channel	23	5	$ 301,000	$ 301,000	5	0	5	1	77%	**68%**
		24	5	$ 6,460,000	$ 6,460,000	1	0	5	3	60%	
6	Gardens Channel/ Adams St	29	5	$ 16,984,000	$16,984,000	1	0	5	3	60%	**60%**
7	Gardens Channel/ Segerstrom Ave	30	5	$ 5,463,000	$ 5,463,000	1	0	5	3	60%	**60%**
8	Gardens Channel	31	5	$ 4,972,000	$ 4,972,000	1	5	5	3	80%	**67%**
		32	5	$ 3,629,000	$ 3,629,000	1	0	5	3	60%	
		33	5	$ 6,236,000	$ 6,236,000	1	0	5	3	60%	
9	Sea Breeze/ Plaza Dr/ Sunflower Ave	40	5	$ 4,117,000	$ 4,117,000	1	0	5	3	60%	**60%**

GREENVILLE BANNING PRIORITIZATION

Greenville Banning Project Prioritization											
Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
GB1	Fairview St from 5th St to Camile St	GB-1 (1 of 3)	3	$ 2,702,809	$ 2,702,809	1	5	3	2	58%	**58%**
GB2	Fairview St from Camile St to McFadden Ave	GB-1 (2 of 3)	4	$ 3,178,006	$ 3,178,006	1	5	5	3	74%	**74%**
GB3	Fairview St from McFadden Ave to Edinger Ave	GB-1 (3 of 3)	5	$ 2,852,185	$ 2,852,185	1	4	5	2	74%	**74%**
GB4	Centennial Rd	GB-2	4	$ 946,000	$ 946,000	3	0	5	1	61%	**61%**
GB5	Castor St/ Harvard St/ Anne St/ Everglade St	GB-3	2	$ 253,000	$ 253,000	5	0	5	1	59%	**59%**
		GB-6	2	$ 58,000	$ 58,000	5	0	5	1	59%	
		GB-7	2	$ 94,000	$ 94,000	5	0	5	1	59%	
GB6	Fairview St/ Segerstrom Ave	GB-8	4	$ 1,184,000	$ 1,184,000	2	0	5	2	57%	**57%**
GB7	Fairview St at Alton Ave/ MacArthur Blvd	GB-12	2	$ 193,000	$ 193,000	5	0	5	1	59%	**61%**
		GB-13	1	$ 22,000	$ 22,000	5	5	3	1	65%	
		GB-14	2	$ 51,000	$ 51,000	5	0	5	1	59%	
GB8	Sergerstrom Ave/ Harbor Gtwy	GB-18	4	$ 2,141,000	$ 2,141,000	1	0	5		49%	**49%**

LANE BARRANCA PRIORITIZATION

Lane Project Prioritization											
Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
1	McFadden Ave at Hathaway St/ Grand Ave/ Edinger Ave	1	1	$ 253,000.00	$ 253,000	5	0	3	1	45%	**48%**
		2	1	$ 297,000.00	$ 297,000	5	0	3	1	45%	
		3	2	$ 655,000.00	$ 655,000	4	0	5	1	54%	
2	Grand Ave/ St Andrew Pl/ Warner Ave/ Union Pacific Railroad	5	4	$ 9,338,000	$ 9,338,000	1	0	5	3	54%	**54%**
3	St Andrew Pl/ Lyon St	6	3	$ 940,000	$ 940,000	3	0	5	1	55%	**55%**
4	Grand Ave north of Dyer Rd	7	5	$ 13,434,000	$13,434,000	1	0	5	3	60%	**60%**
5	Tech Center Dr/ Hotel Terrace Dr	10	5	$ 2,906,000	$ 2,906,000	1	5	5	2	78%	**78%**
6	Tech Center Dr/ Columbine Ave/ First American Way	11	1	$ 32,000	$ 32,000	5	0	5	1	53%	**55%**
		13	2	$ 820,000	$ 820,000	3	0	5	1	49%	
		14	2	$ 332,000	$ 332,000	5	0	5	1	59%	
		15	1	$ 1,664,000	$ 1,664,000	2	5	5	2	59%	

SANTA ANA PRIORITIZATION

Santa Ana Project Prioritization											
Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
SA1	Flower St/ Farmers Dr	9	1	$ 49,000	$ 49,000	5	0	3	1	45%	**44%**
		13	3	$ 1,176,000	$ 1,176,000	2	0	3	2	43%	
SA2	Bristol St/ Park Ln	10	3	$ 2,435,000	$ 2,435,000	1	0	5	2	46%	**46%**
SA3	Westminster Ave/ Fairview St	11	3	$ 1,988,000	$ 1,988,000	2	5	5	2	71%	**71%**
SA4	17th St	14 (1of2)	5	$ 4,255,000	$ 4,255,000	1	0	5	3	60%	**60%**
SA5	17th St/ Baker St/ Westwood Ave/ Towner St	14 (2of2)	2	$ 1,165,000	$ 1,165,000	2	5	5	2	65%	**65%**
SA6	21st St	15	3	$ 813,000	$ 813,000	3	0	5	1	55%	**55%**
SA7	Baker St/ Washington Ave/ English St/ King St	16	4	$ 2,773,000	$ 2,773,000	1	4	5	2	68%	**68%**
SA8	West of Civic Center Dr	17	2	$ 682,000	$ 682,000	4	0	3		44%	**44%**

SANTA FE GRAND PRIORITIZATION

Grand Project Prioritization											
Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
G1	Old Grand St/ Santa Clara Ave/ Lincoln Ave	1	1	$ 661,000	$ 661,000	4	0	5	1	48%	**48%**
		2	2	$ 2,466,000	$ 2,466,000	1	0	5	2	40%	
G2	Lincoln Ave/ 17th St	3	3	$ 5,081,000	$ 5,081,000	1	0	5	3	48%	**48%**
G3	17th St	4	3	$ 1,337,000	$ 1,337,000	2	0	3	2	43%	**43%**
G4	4th St	5	3	$ 923,000	$ 923,000	3	5	3	1	67%	**67%**
G5	Grand Ave	6	5	$ 11,376,000	$11,376,000	1	0	5	3	60%	**60%**

SANTA FE TUSTIN PRIORITIZATION

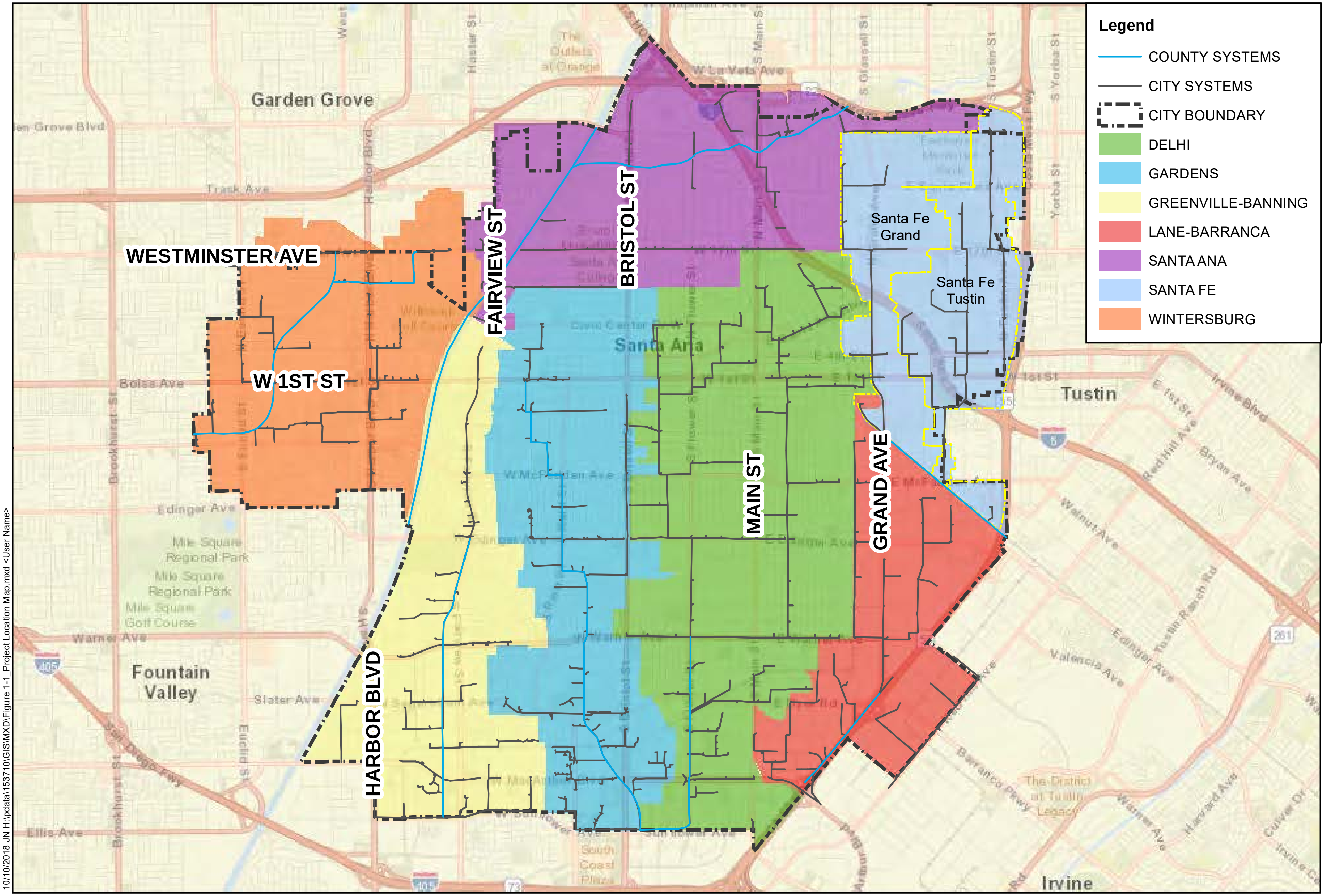
Tustin Project Prioritization											
Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
T1	Millwood St/ Tustin Ave/ 20th St	1 (1of2)	2	$ 333,000	$ 333,000	5	0	4	1	55%	**55%**
T2	Williams St/ Wellington Avce/ Fruit St/ Eastside Ave/ Cabrillo Park Dr	1 (2of2)	2	$ 1,649,000	$ 1,649,000	2	0	5	2	45%	**45%**
T3	Tustin Ave/ 17th St	2	5	$ 2,842,000	$ 2,842,000	1	1	5	2	62%	**62%**

WINTERSBURG PRIORITIZATION

Wintersburg Project Prioritization											
Project #	Project Location	Subarea #	DS/US Priority	Project Cost	Total Project Cost	Cost Priority	Known Flooded Areas Priority	Depth of Flooding Priority	Drainage System	Weighted Score	**Project Weighted Score**
W1	Clinton St/ Harper St	1	1	$ 101,000	$ 101,000	5	0	5	1	53%	**53%**
W2	Harbor Blvd	5	3	$ 1,816,000	$ 1,816,000	2	0	5	2	51%	**51%**
W3	Newhope St/ West of Kona Ave/ Harbor Blvd	8	2	$ 679,000	$ 679,000	4	0	1	1	38%	**47%**
		18	2	$ 437,000	$ 437,000	5	0	3	1	51%	
		32	1	$ 40,000	$ 40,000	5	0	5	1	53%	
W4	Sail St	14	2	$ 365,000	$ 365,000	5	0	3	1	51%	**51%**
W5	5th St/ East of Newhope St	15	4	$ 1,593,000	$ 1,593,000	2	0	5	2	57%	**57%**

TECHNICAL APPENDIX H

Report Exhibits



10/10/2018 JN H:\pdata\153710\GIS\MXD\Figure 1-1_Project Location Map.mxd <User Name>

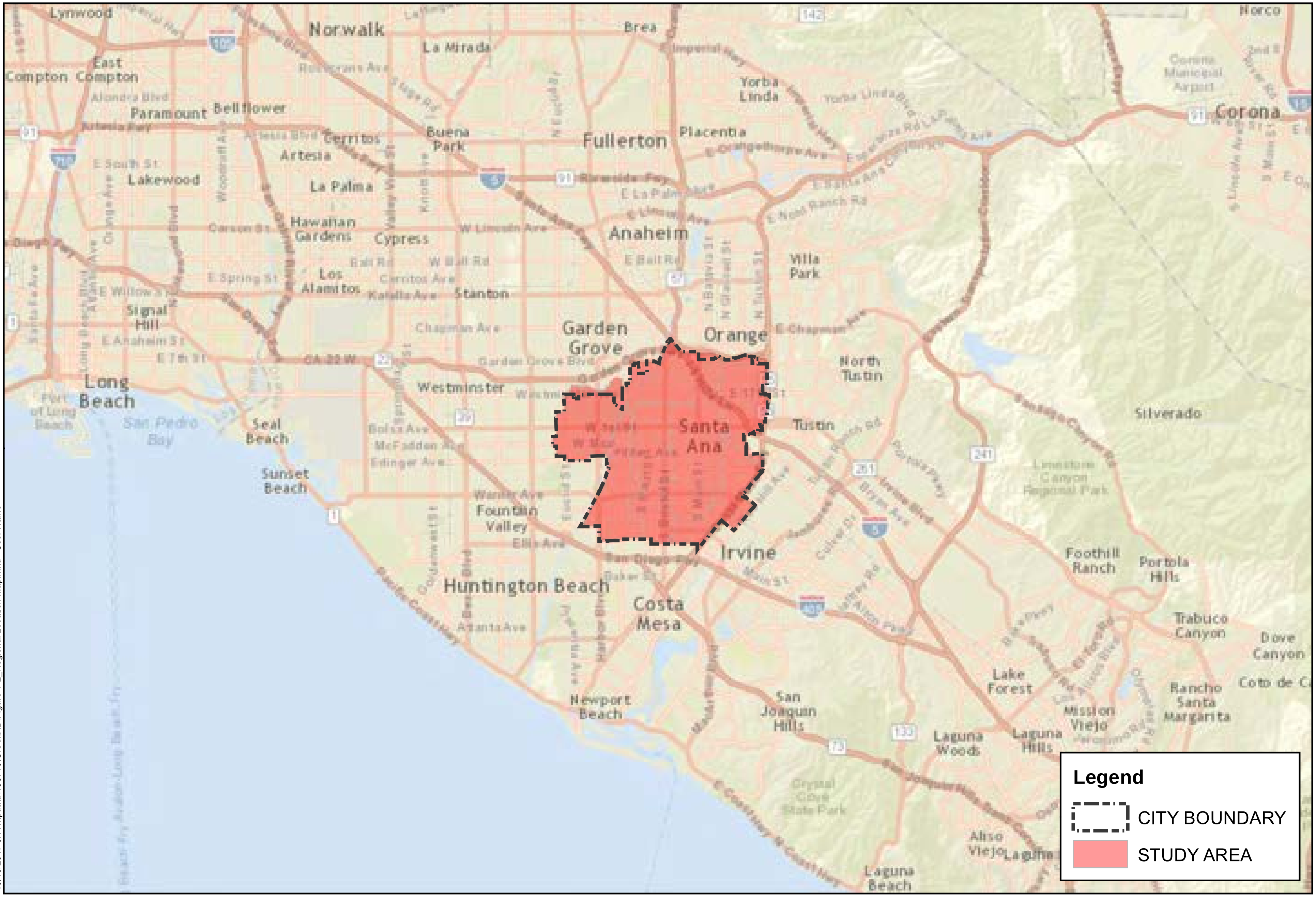
Michael Baker INTERNATIONAL

Source:

SANTA ANA MASTER PLAN OF DRAINAGE

Project Location Map

Figure 1-1



Michael Baker INTERNATIONAL

0 2.5 5 Miles

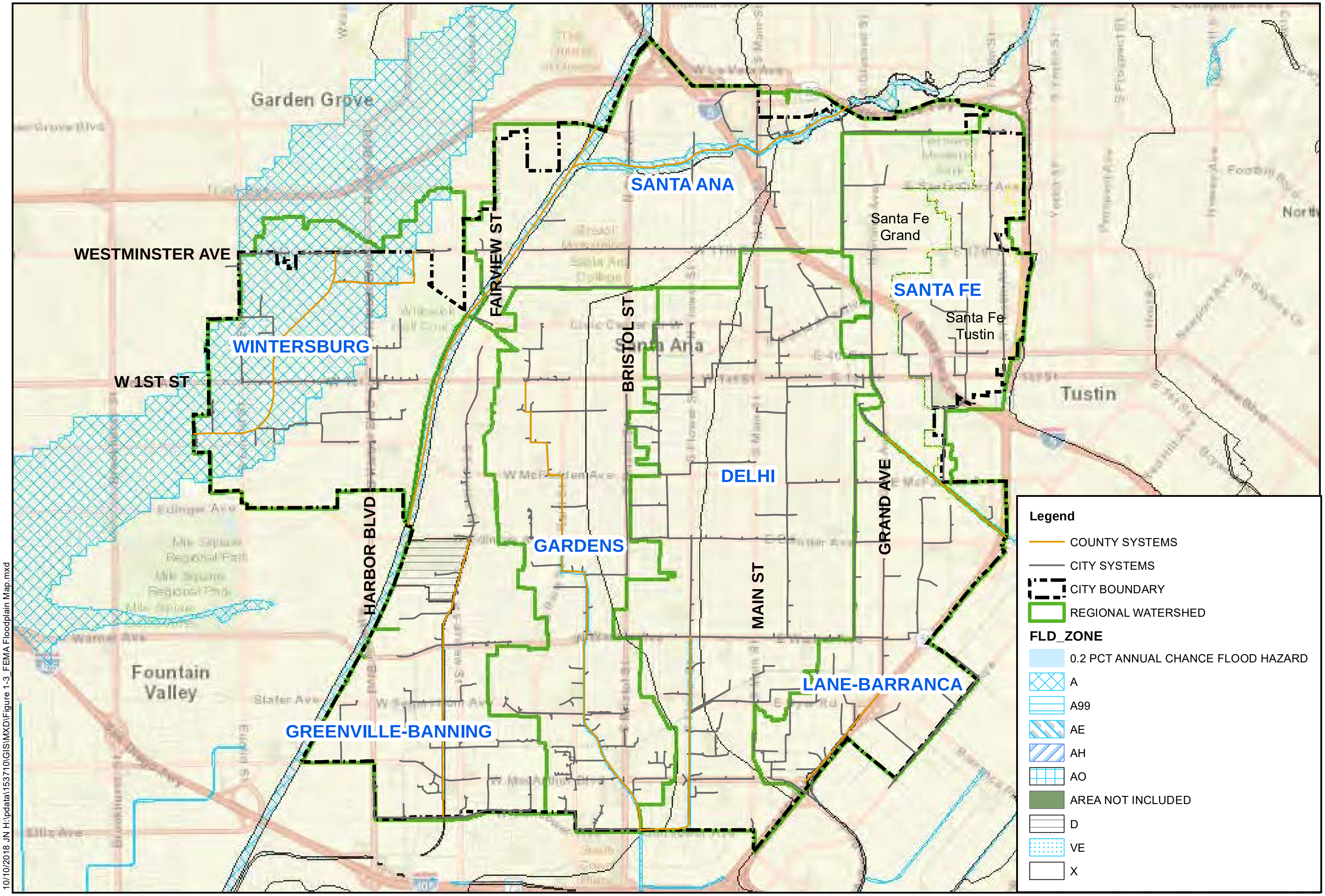
Source:

SANTA ANA MASTER PLAN OF DRAINAGE

Regional Location Map

Figure 1-2

10/16/2017 JN H:\pdata\153710\GIS\MXD\Figure 1-2_Regional Location Map.mxd <User Name>



10/10/2018 JN H:\pdata\153710\GIS\MXD\Figure 1-3_FEMA Floodplain Map.mxd

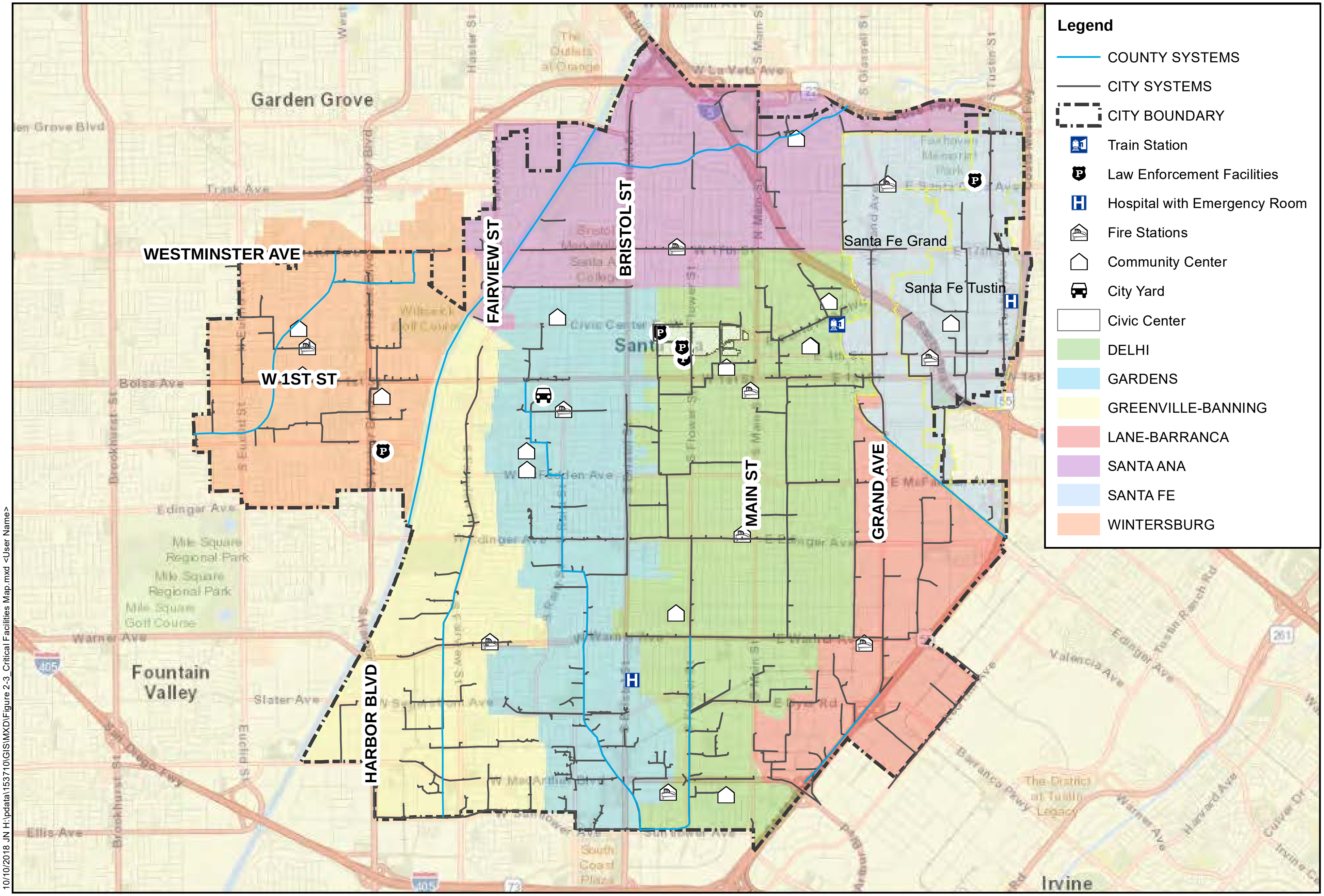
Michael Baker INTERNATIONAL

Source:

SANTA ANA MASTER PLAN OF DRAINAGE

FEMA Floodplain Map

Figure 1-3



10/10/2018 JN H:\pdata\153710\GIS\MXD\Figure 2-3_Critical Facilities Map.mxd <User Name>

Michael Baker INTERNATIONAL

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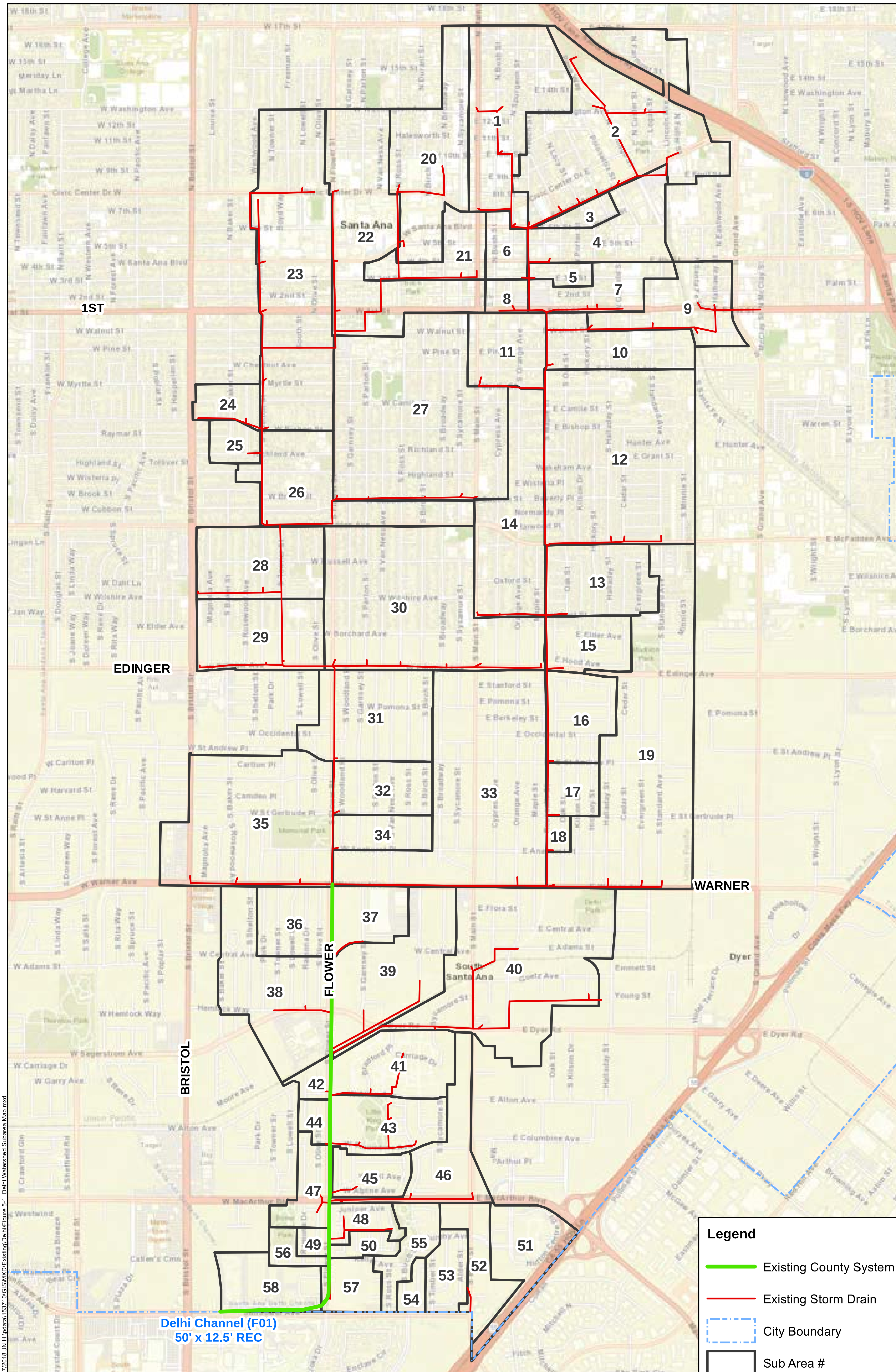
Source:

SANTA ANA MASTER PLAN OF DRAINAGE

Critical Facilities Map

Figure 2-3

DELHI EXHIBITS

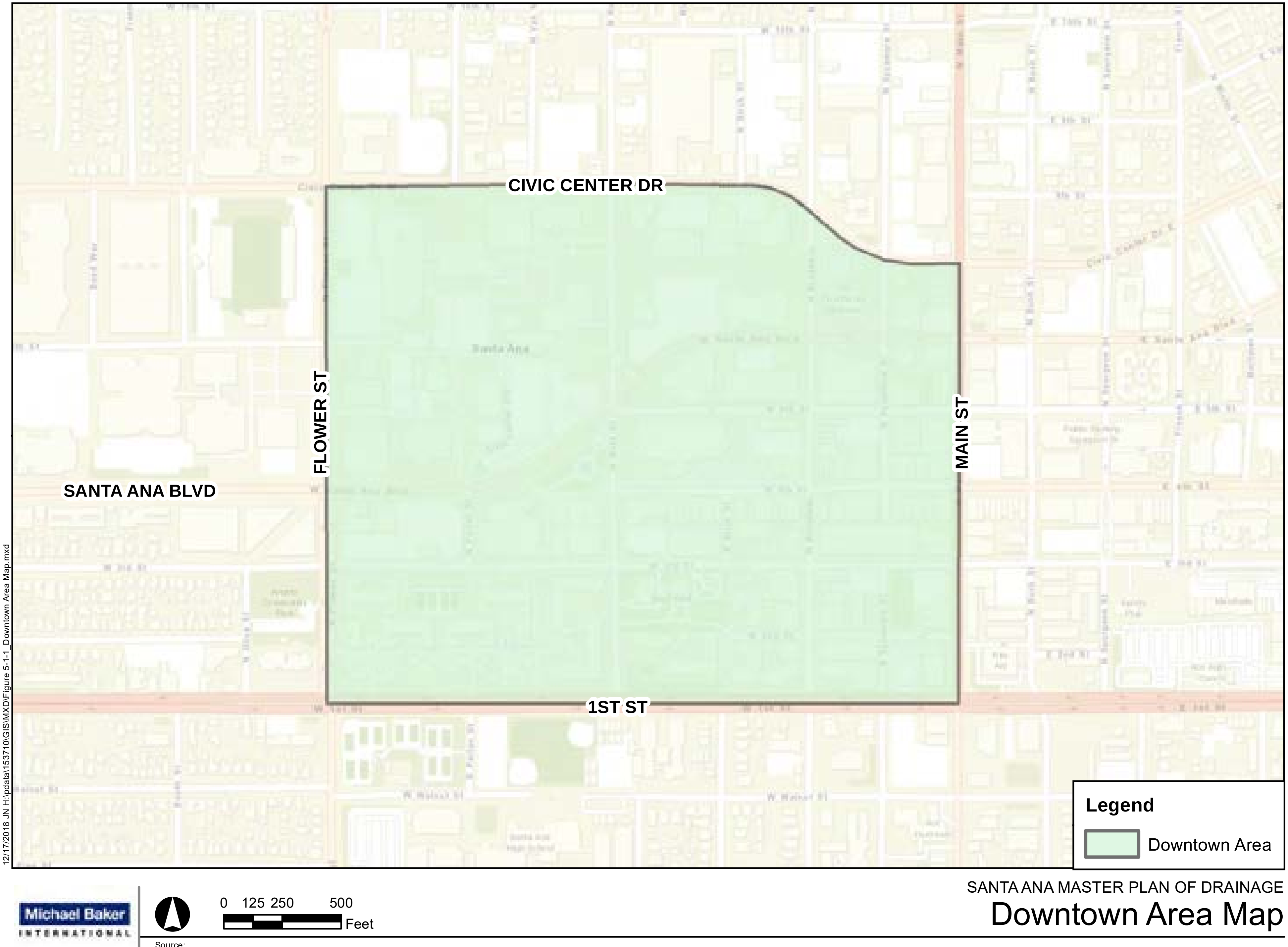


Michael Baker INTERNATIONAL

0 1,000 2,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED
Watershed Subarea Map

Figure 4-1



12/17/2018 JN H:\pdata\153710\GIS\MXD\Figure 5-1-1_Downtown Area Map.mxd

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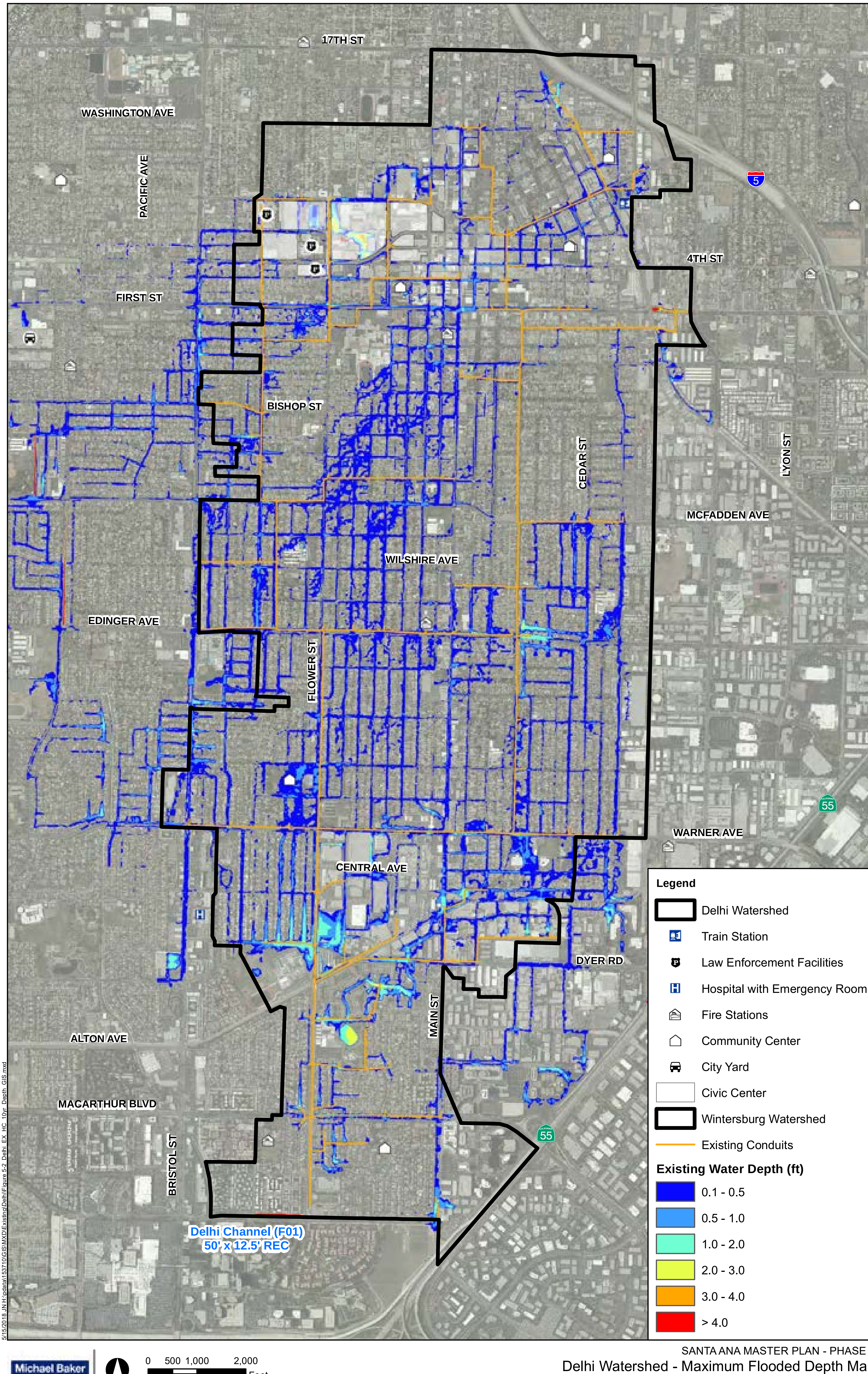
SANTA ANA MASTER PLAN OF DRAINAGE

Downtown Area Map

Figure 4-1.1



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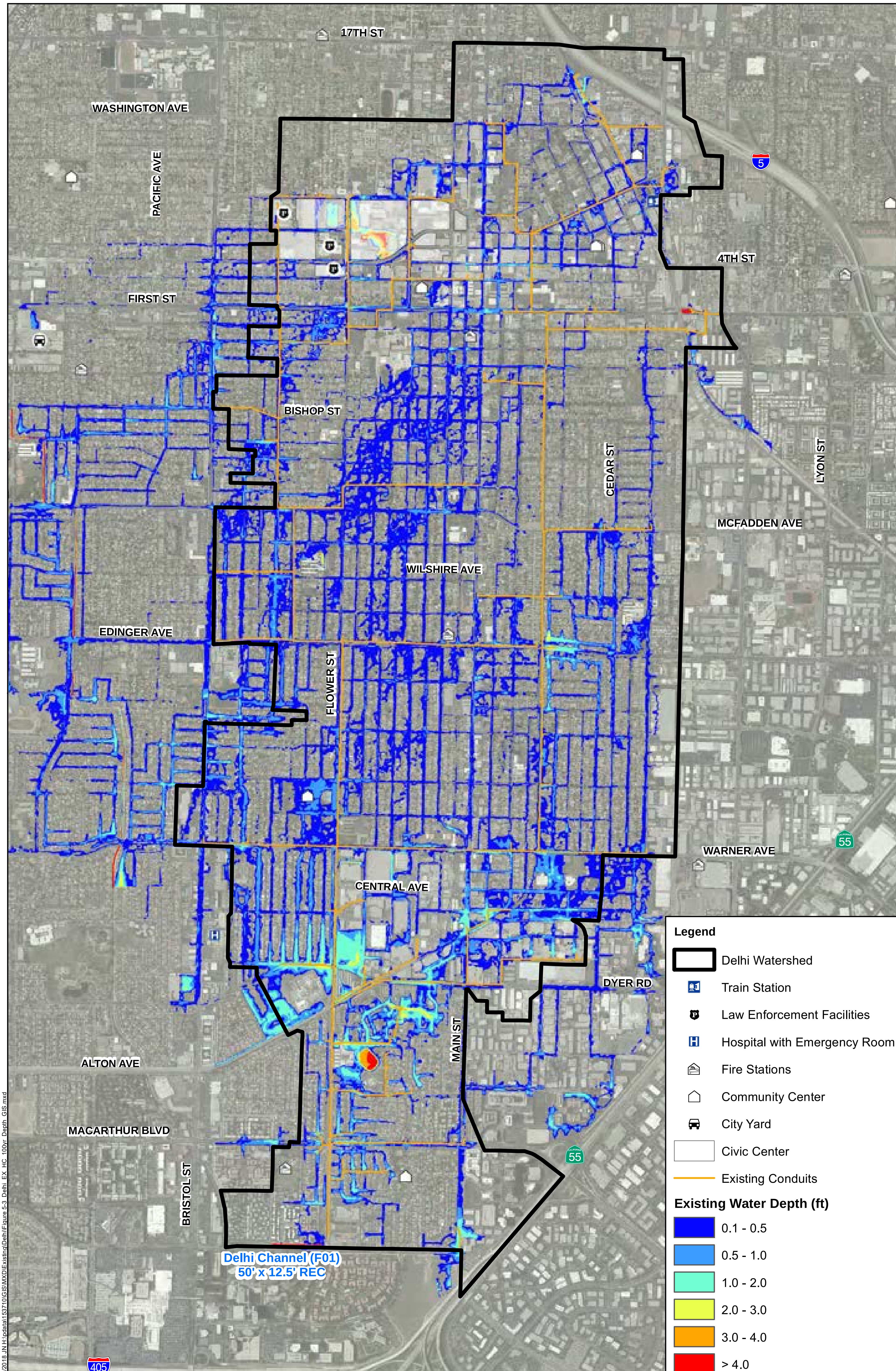
SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - Maximum Flooded Depth Map

10- year Existing Condition

Figure 4-2



5/15/2018 JN H:\pdata\153710\GIS\MXD\Existing\Delhi\Figure 5-3 Delhi_EX_HC_100yr_Depth_GIS.mxd

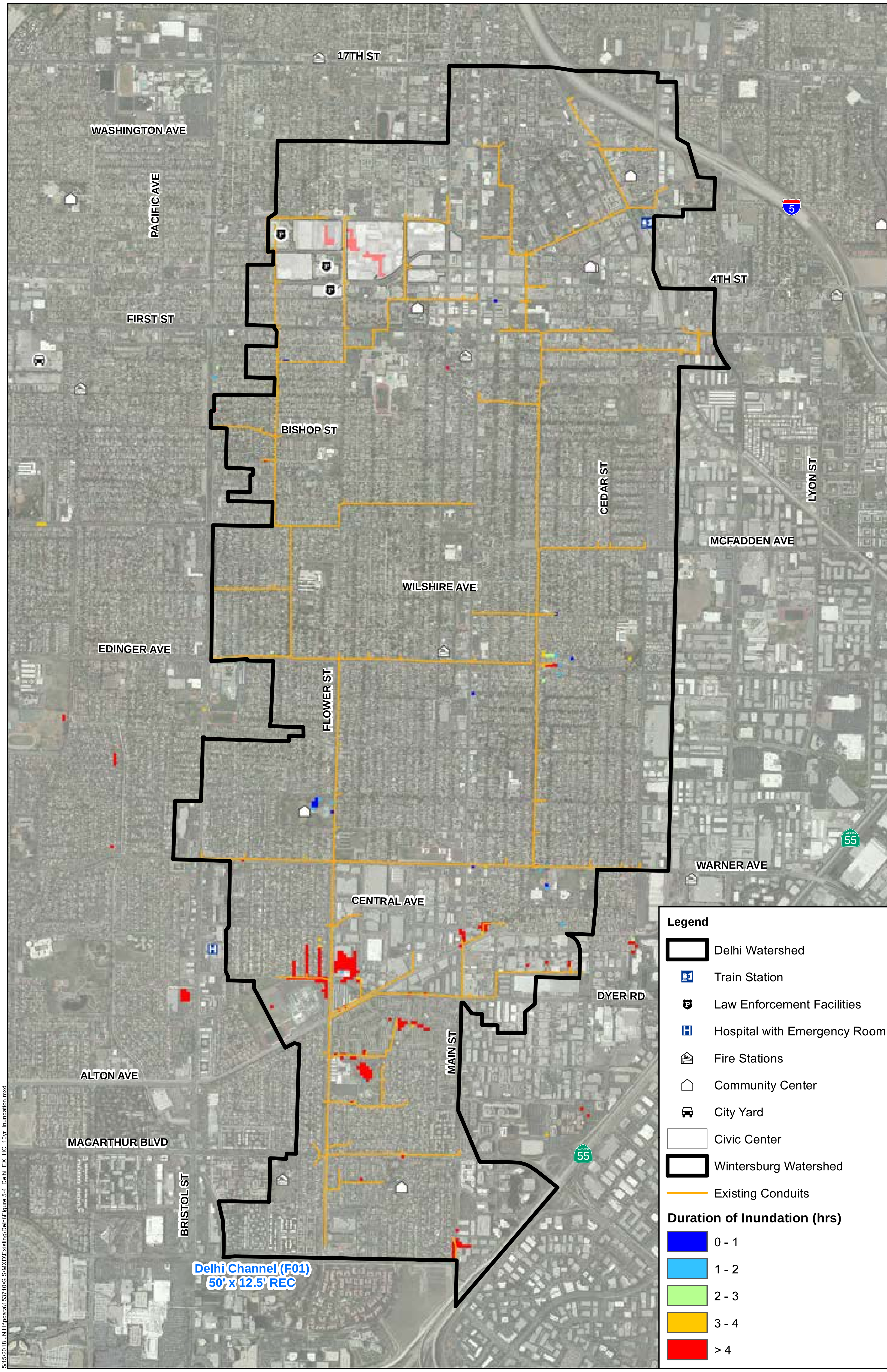
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - Maximum Flooded Depth Map

100- year Existing Condition

Figure 4-3



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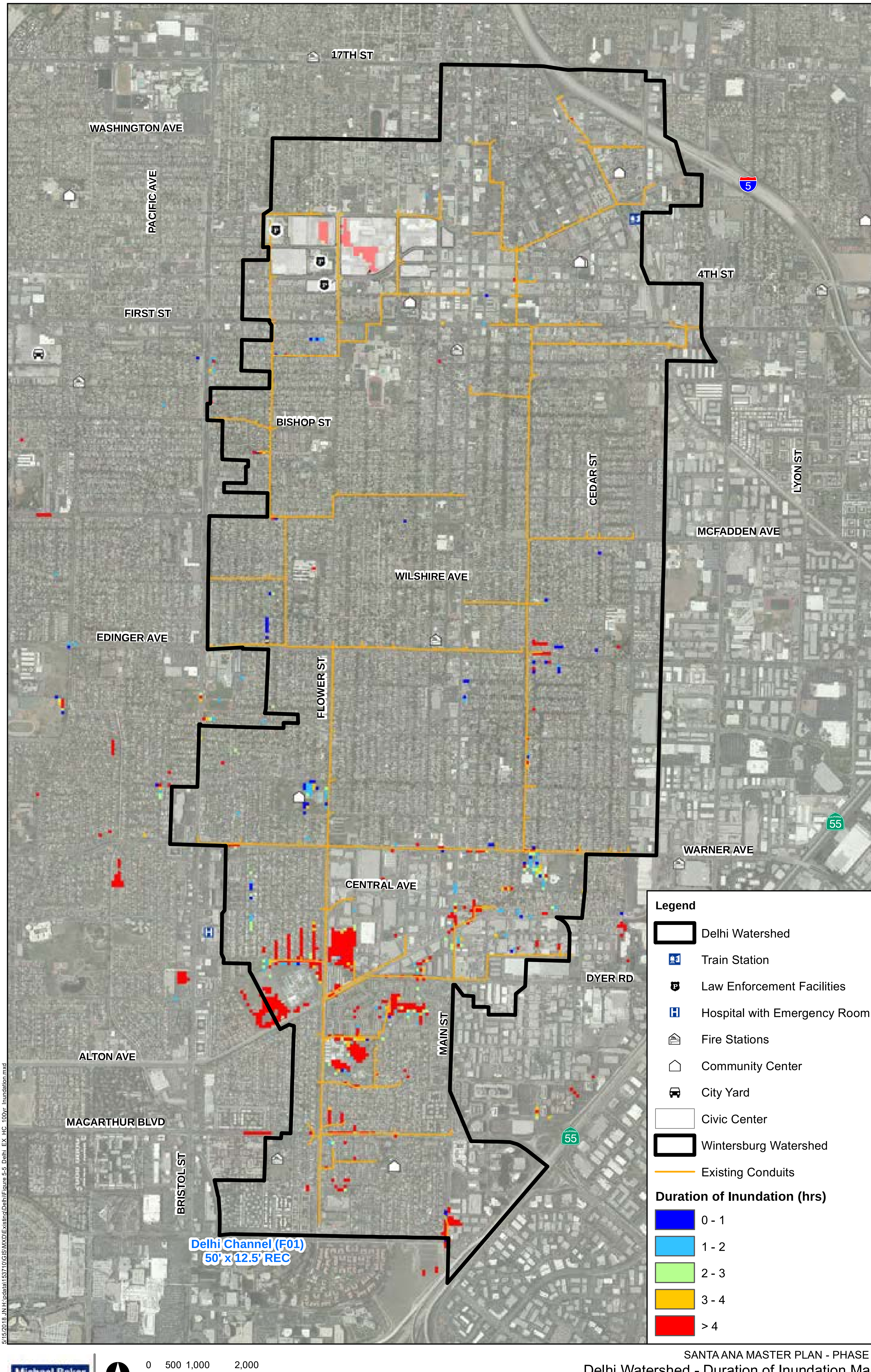
SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - Duration of Inundation Map
10- year Existing Condition

Figure 4-4



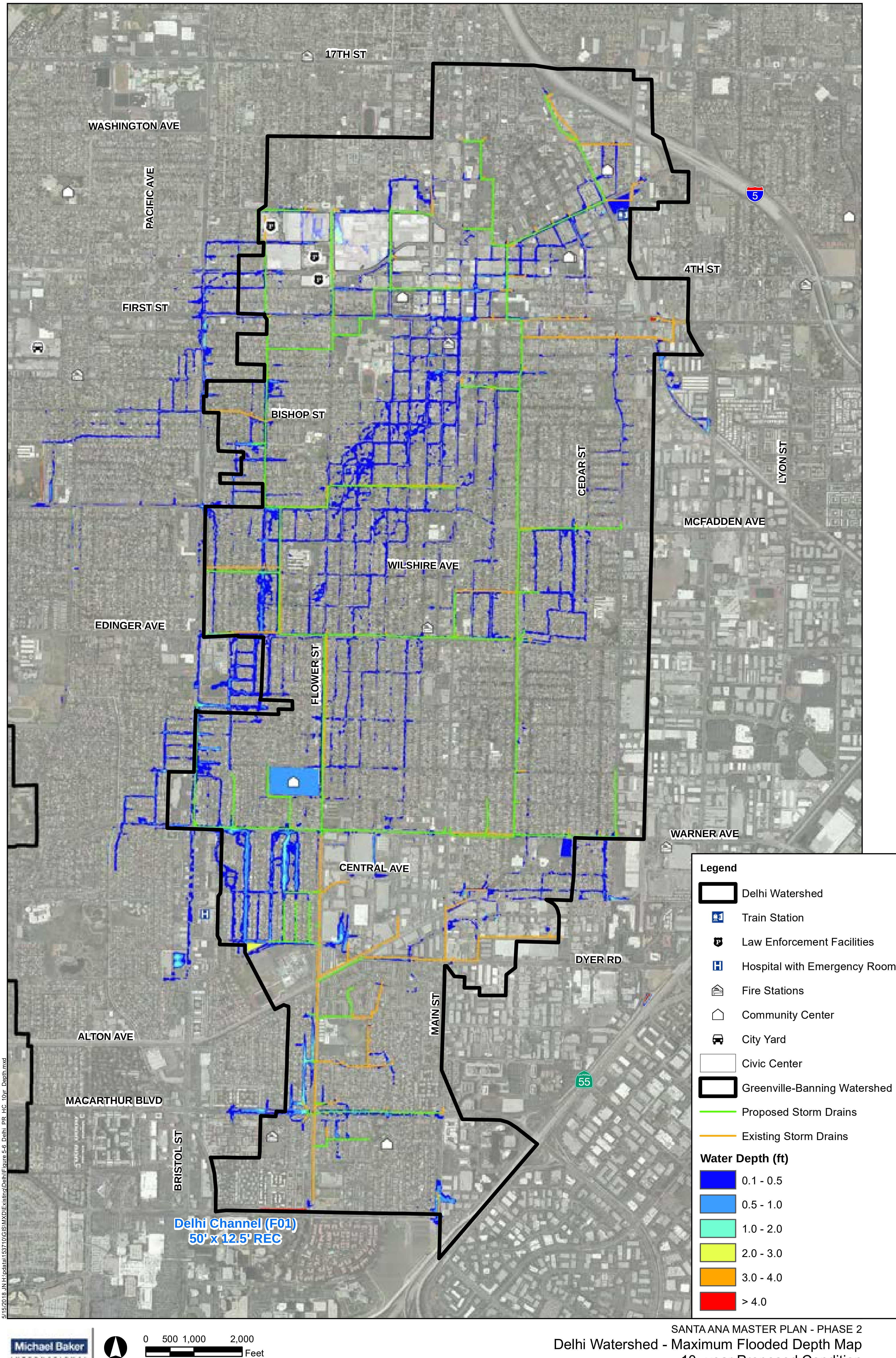
5/15/2018 JN H:\pdata\153710\GIS\MXD\Existing\Delhi\Figure 5-5 Delhi_EX_HC_100yr_Inundation.mxd

SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - Duration of Inundation Map

100- year Existing Condition

Figure 4-5



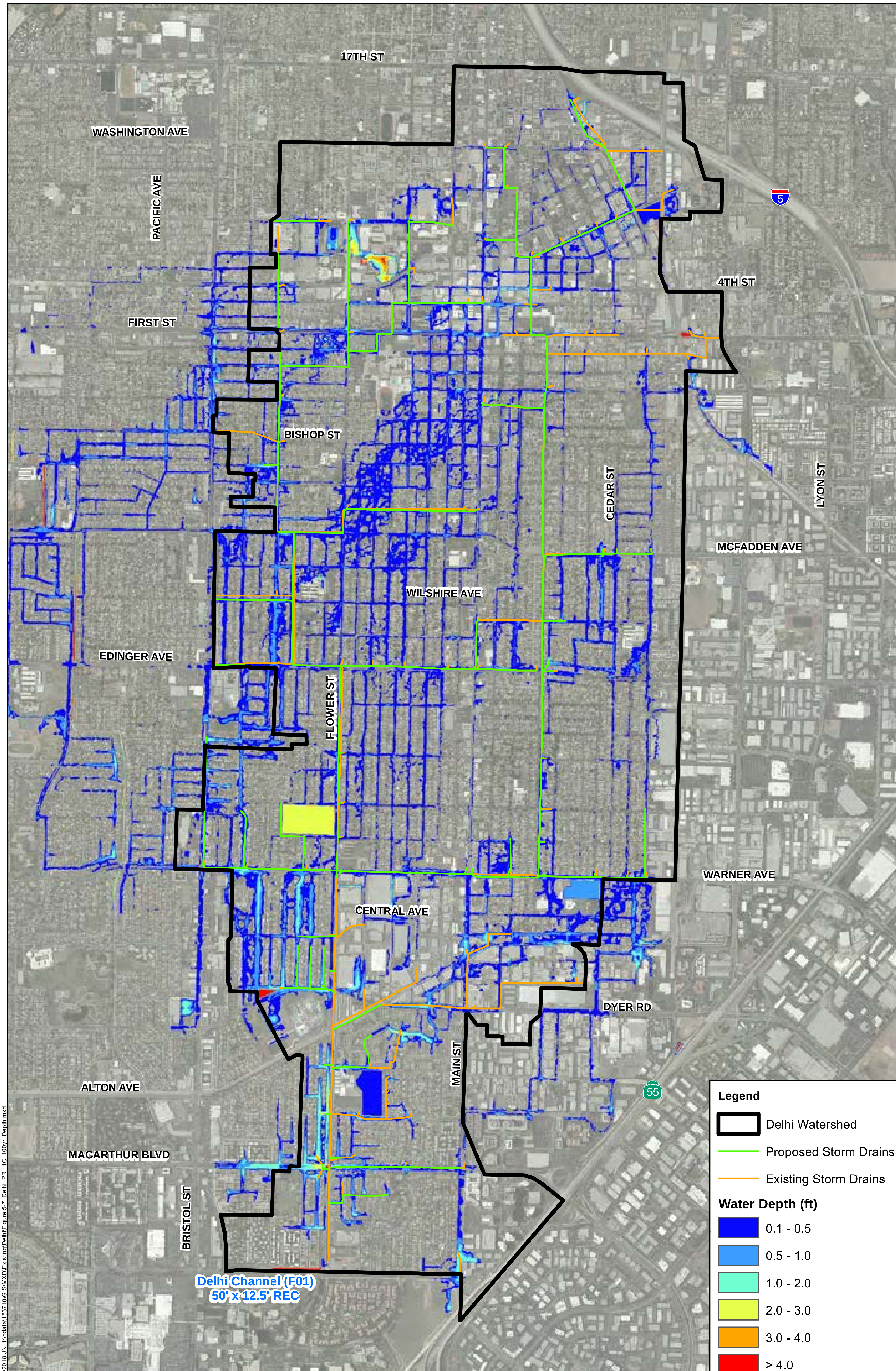
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - Maximum Flooded Depth Map

10- year Proposed Condition

Figure 4-6



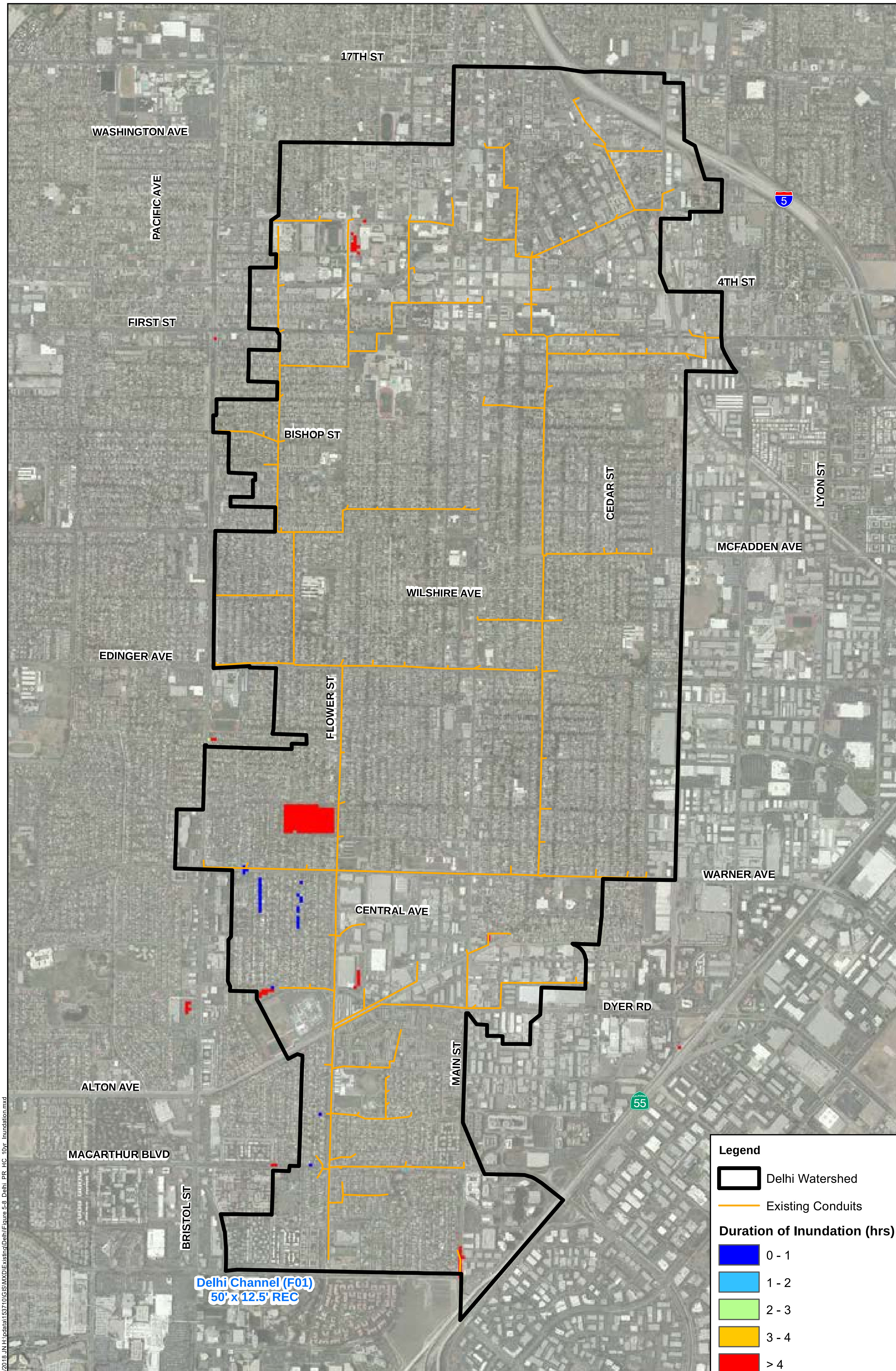
0 500 1,000 2,000
Feet

SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - Maximum Flooded Depth Map

100- year Proposed Condition

Figure 4-7



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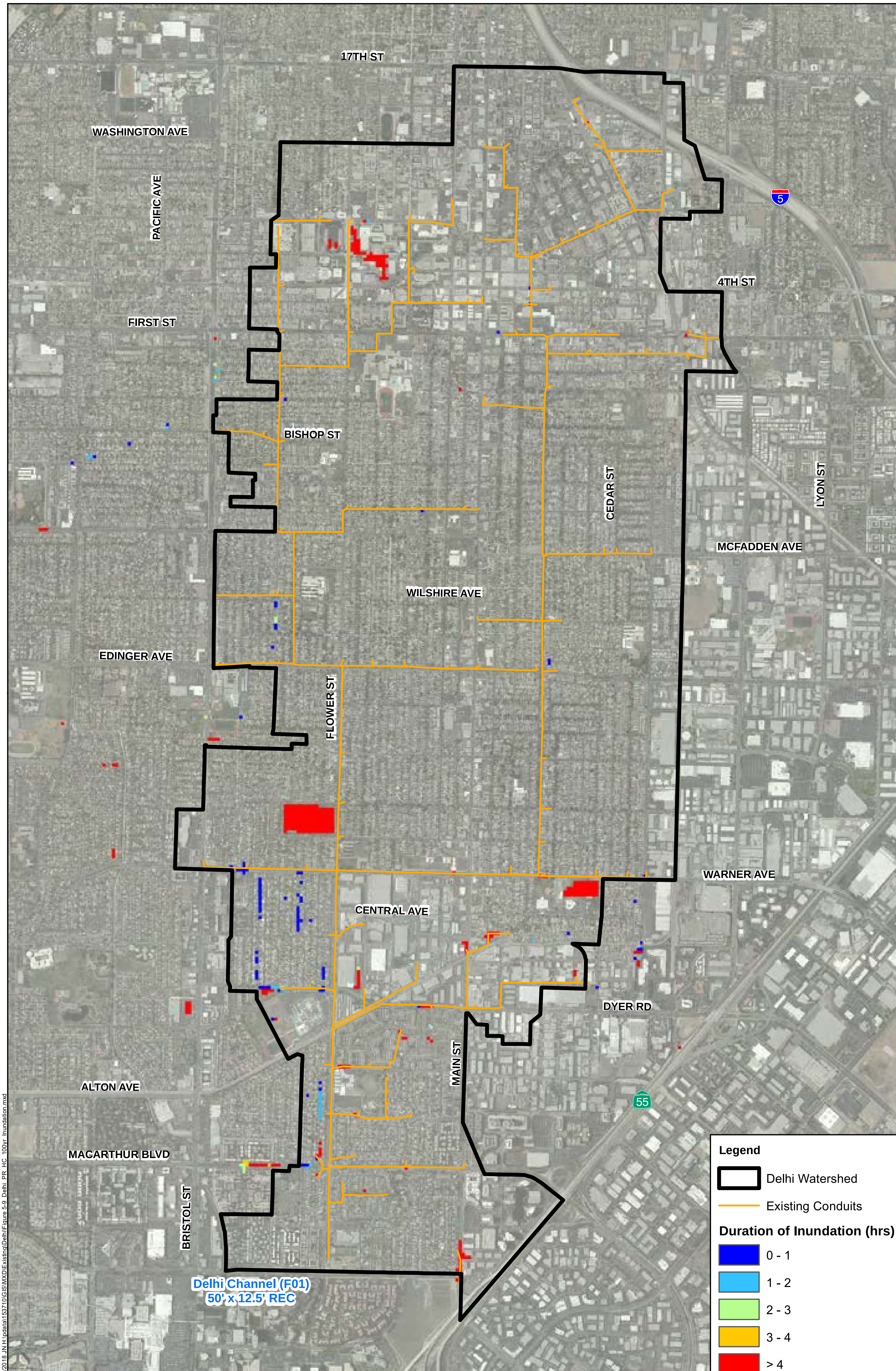
SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - Duration of Inundation Map

10- year Proposed Condition

Figure 4-8



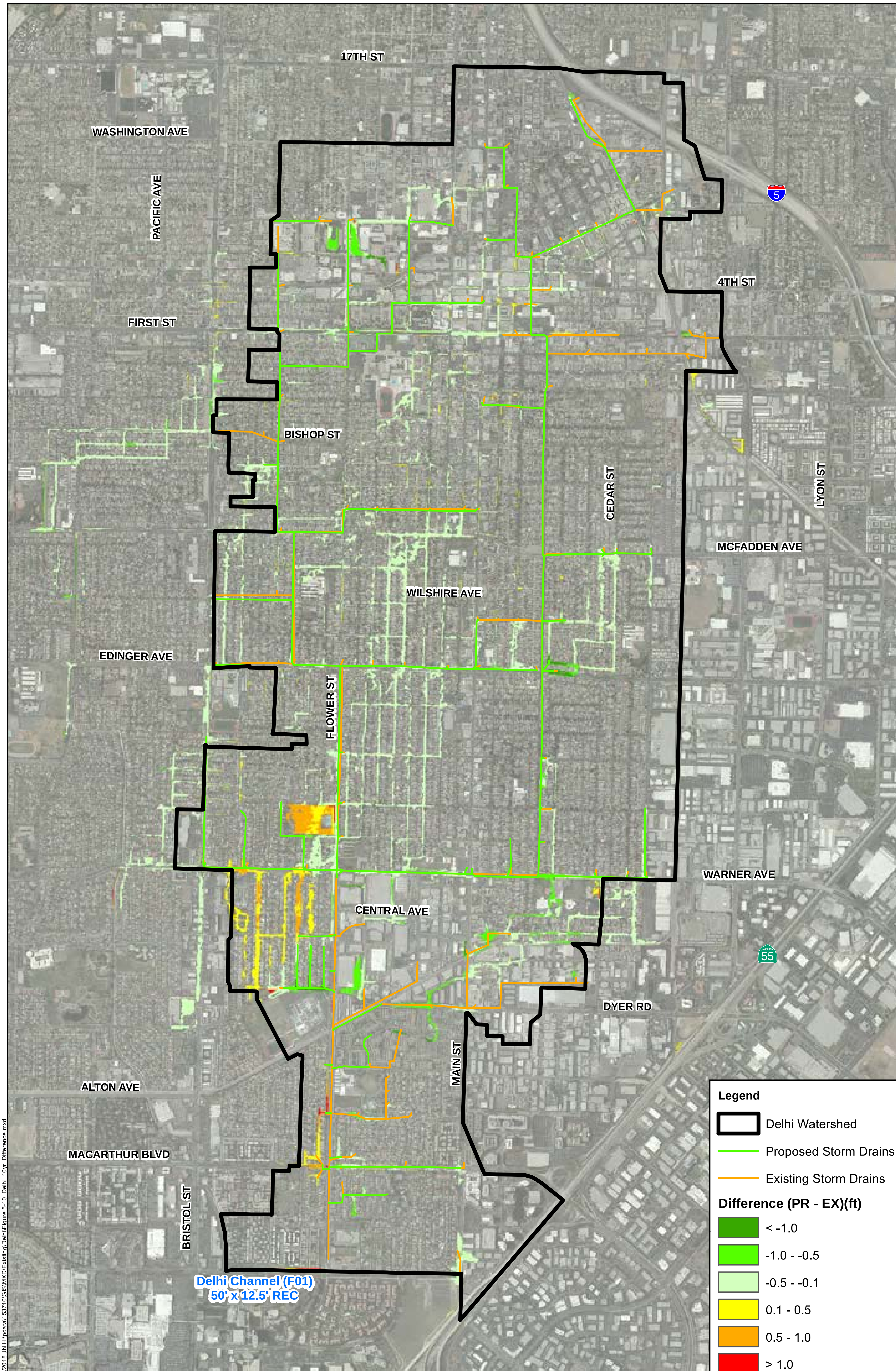
0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - Duration of Inundation Map

100- year Proposed Condition

Figure 4-9



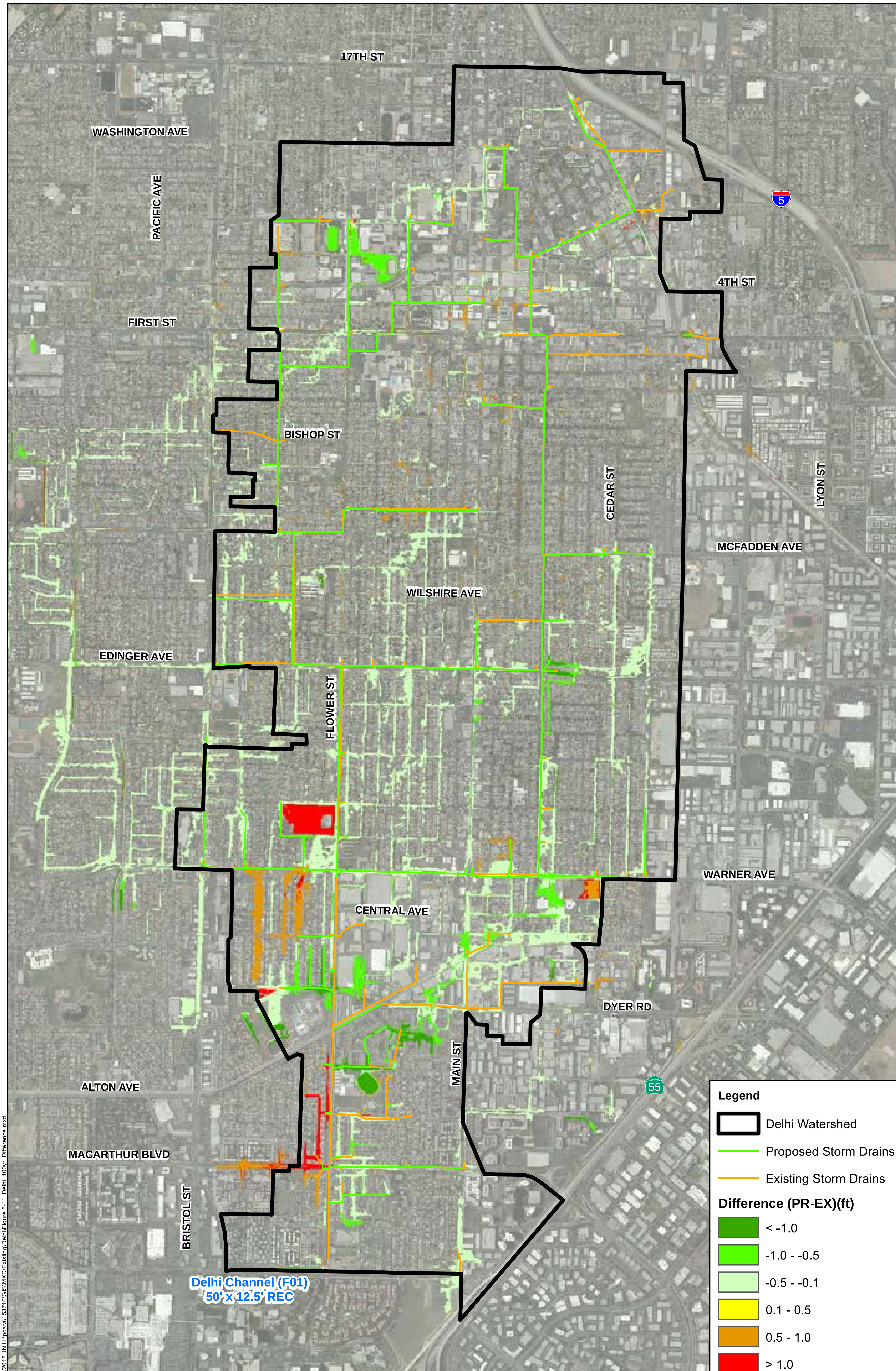
Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - 10- year Difference Map

Figure 4-10

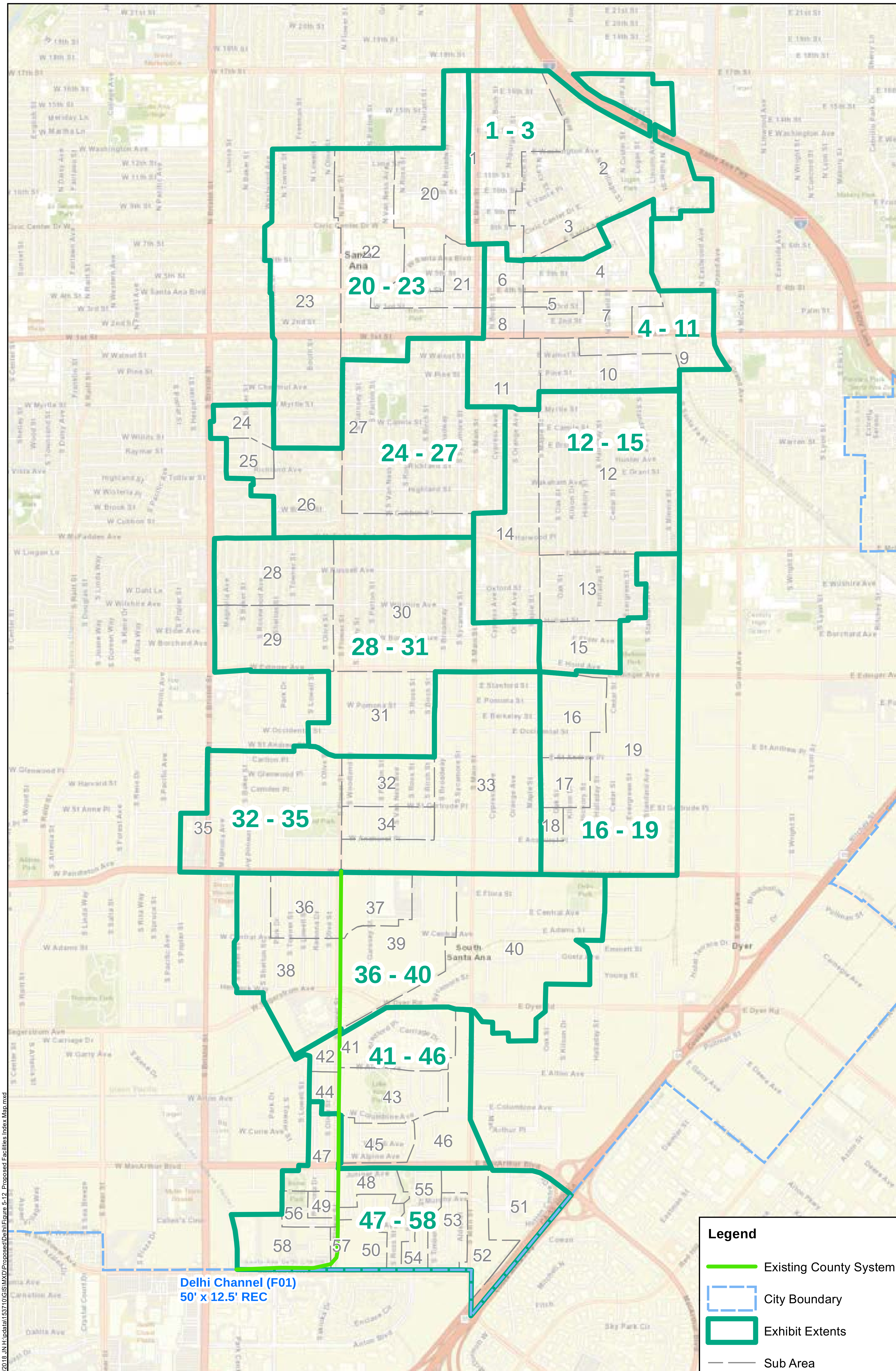


0 500 1,000 2,000
Feet

SANTA ANA MASTER PLAN - PHASE 2

Delhi Watershed - 100- year Difference Map

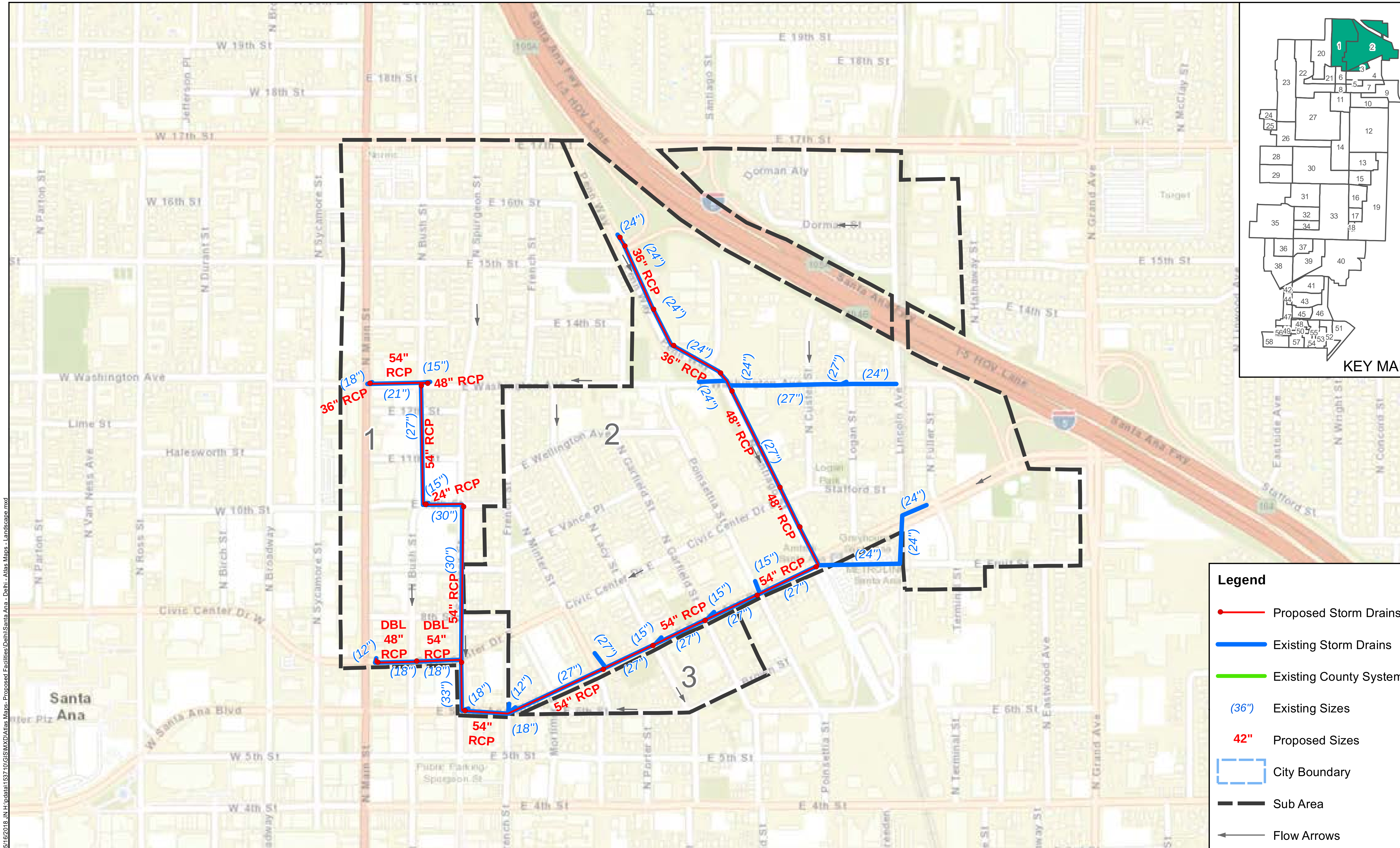
Figure 4-11



SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

Proposed Facilities - Exhibit Extents Index Map

Figure 4-12



0 500 1,000 Feet

Source:

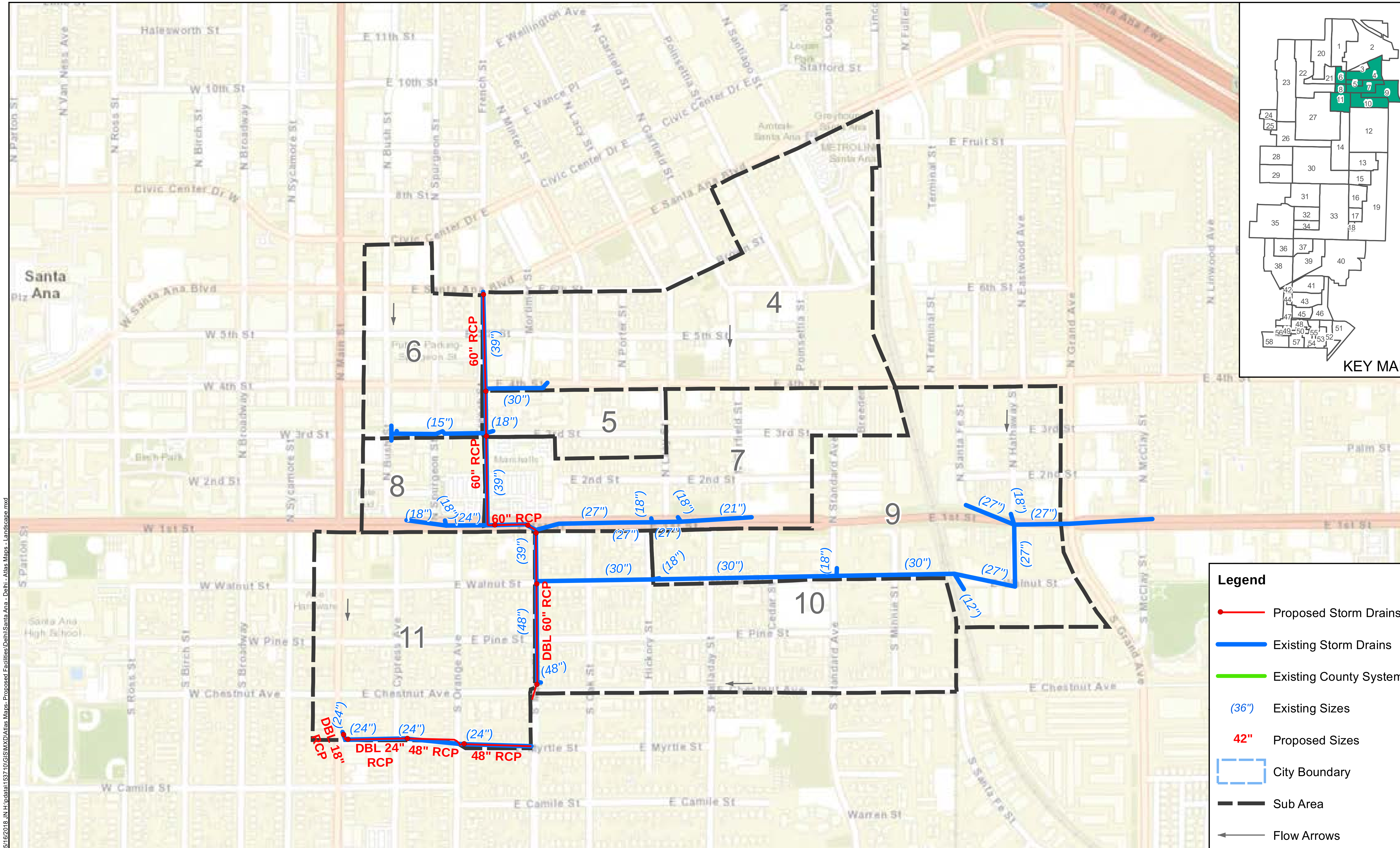
Michael Baker INTERNATIONAL

5/16/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps - Proposed Facilities\Delhi\Santa Ana - Delhi - Atlas Maps - Landscape.mxd

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 1 - 3

FIGURE 4-13



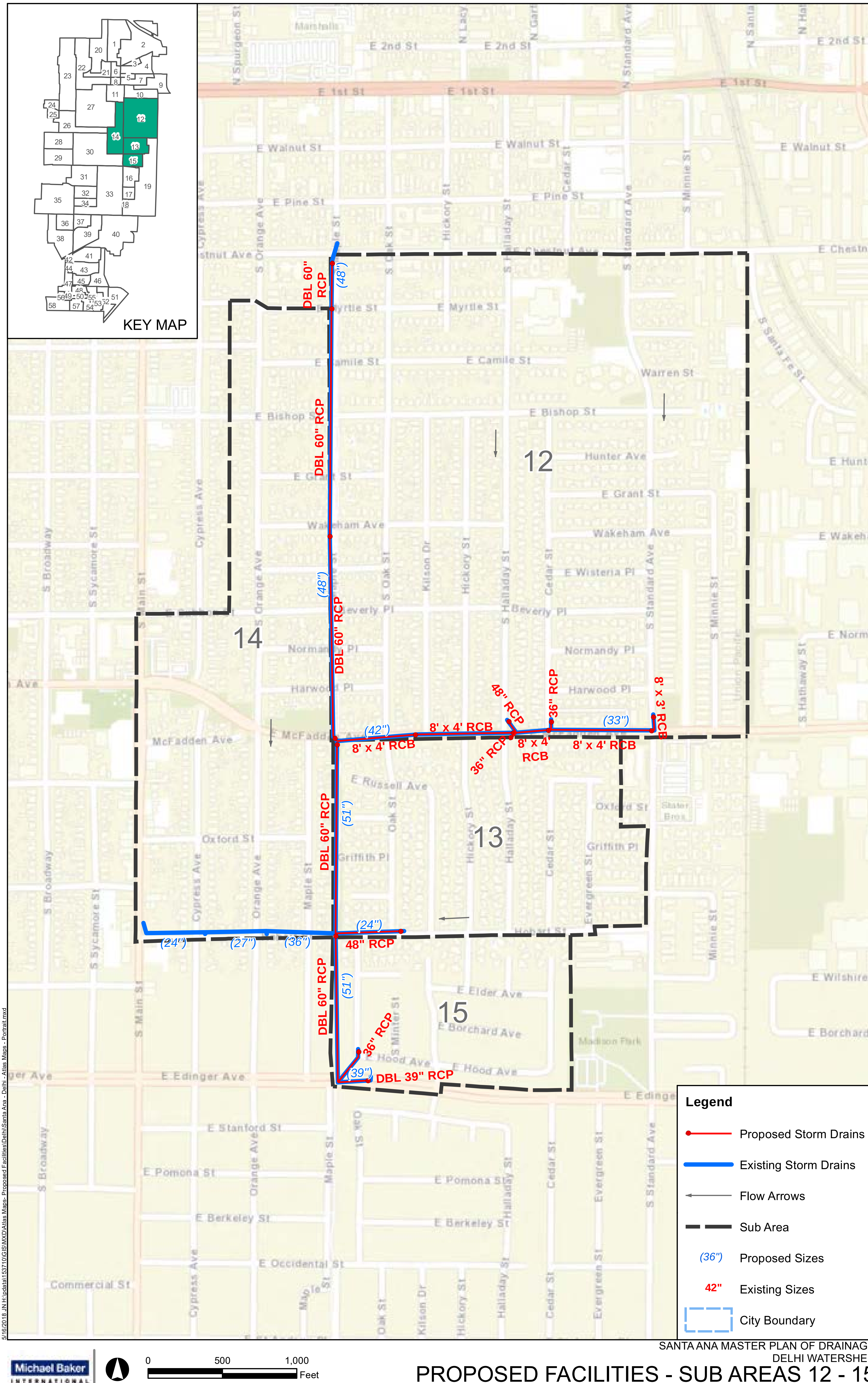
0 500 1,000 Feet

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 4 - 11

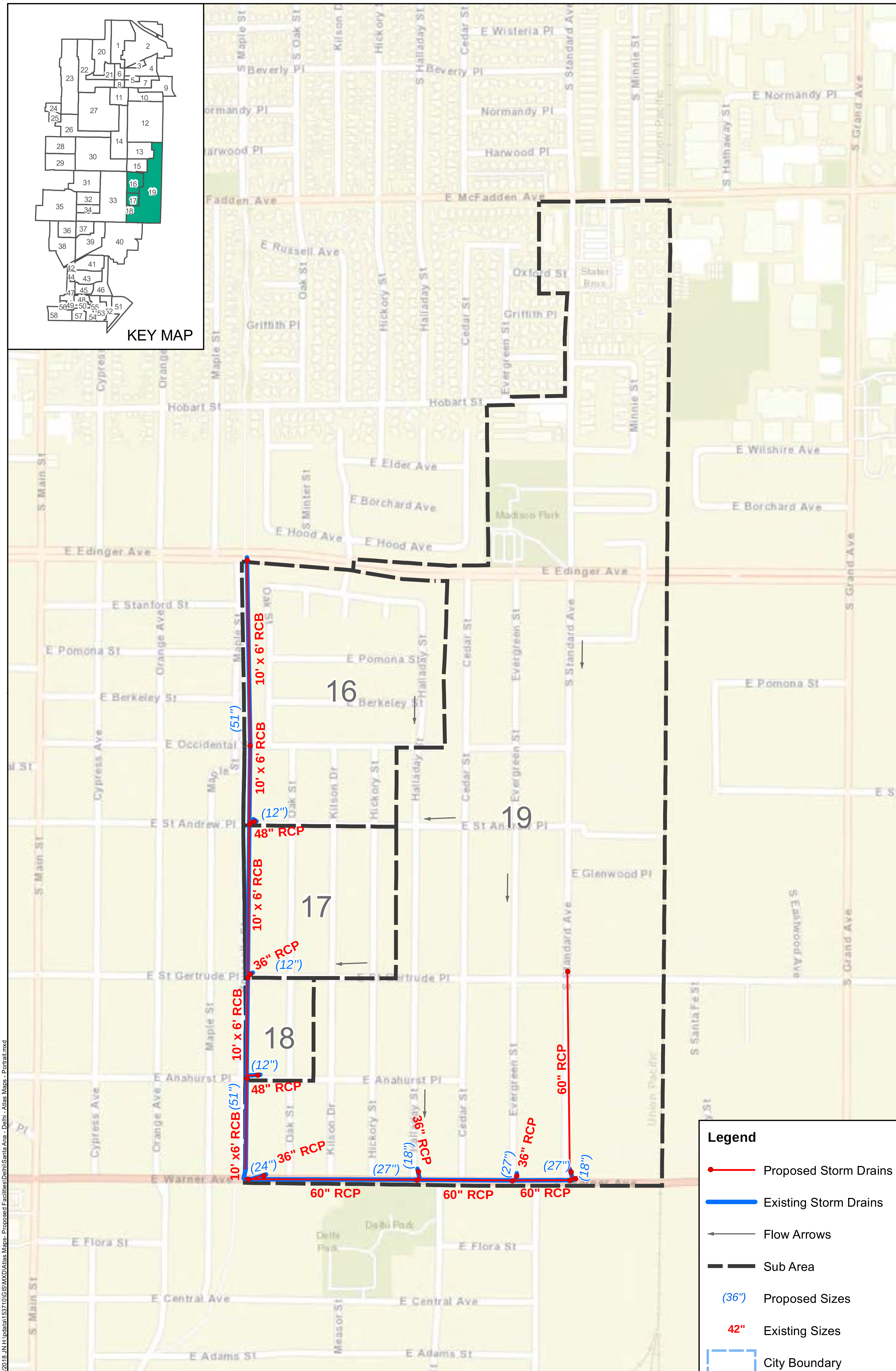
FIGURE 4-14



SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 12 - 15

FIGURE 4-15



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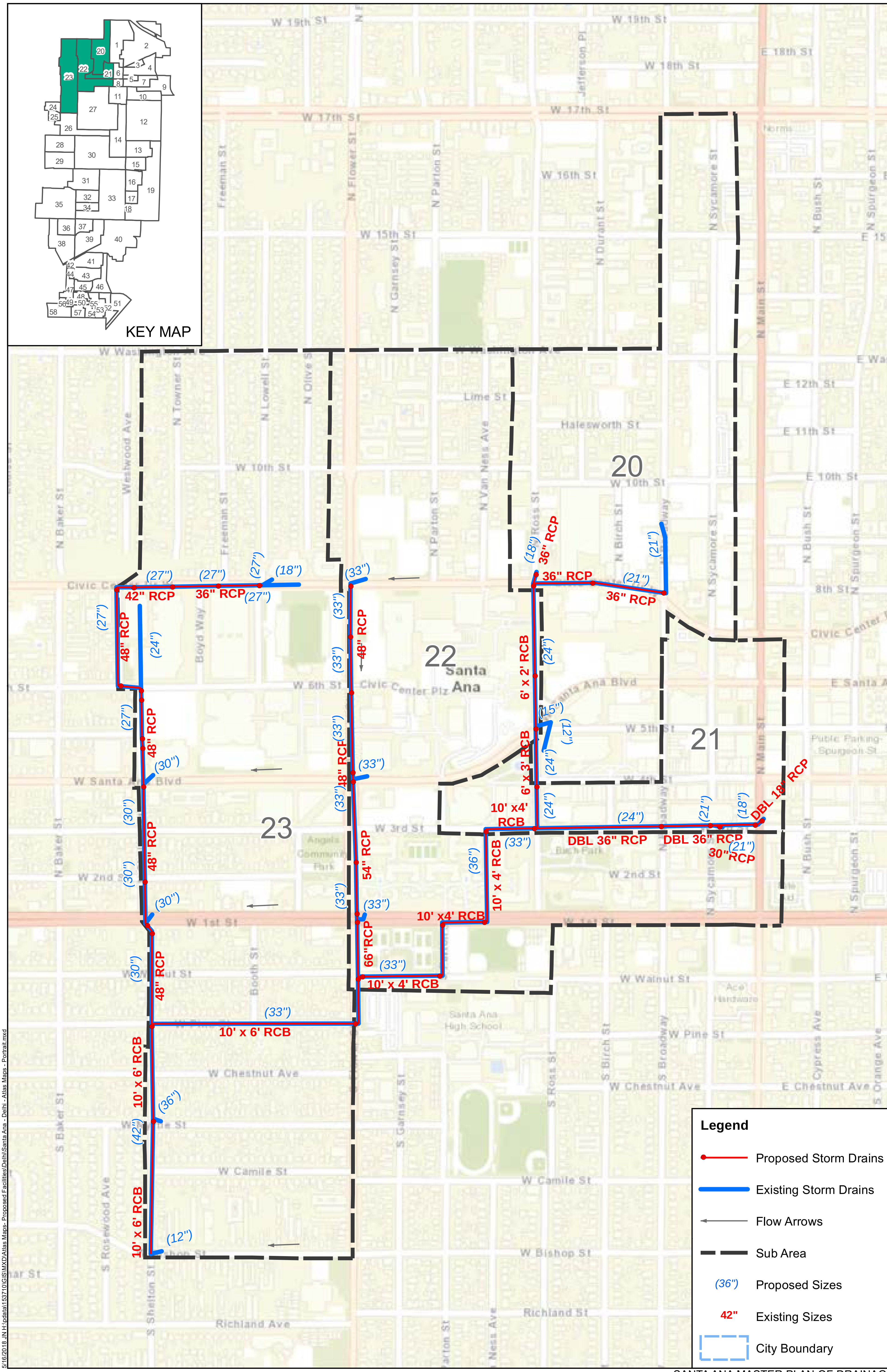
Michael Baker INTERNATIONAL

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 16 - 19

FIGURE 4-16

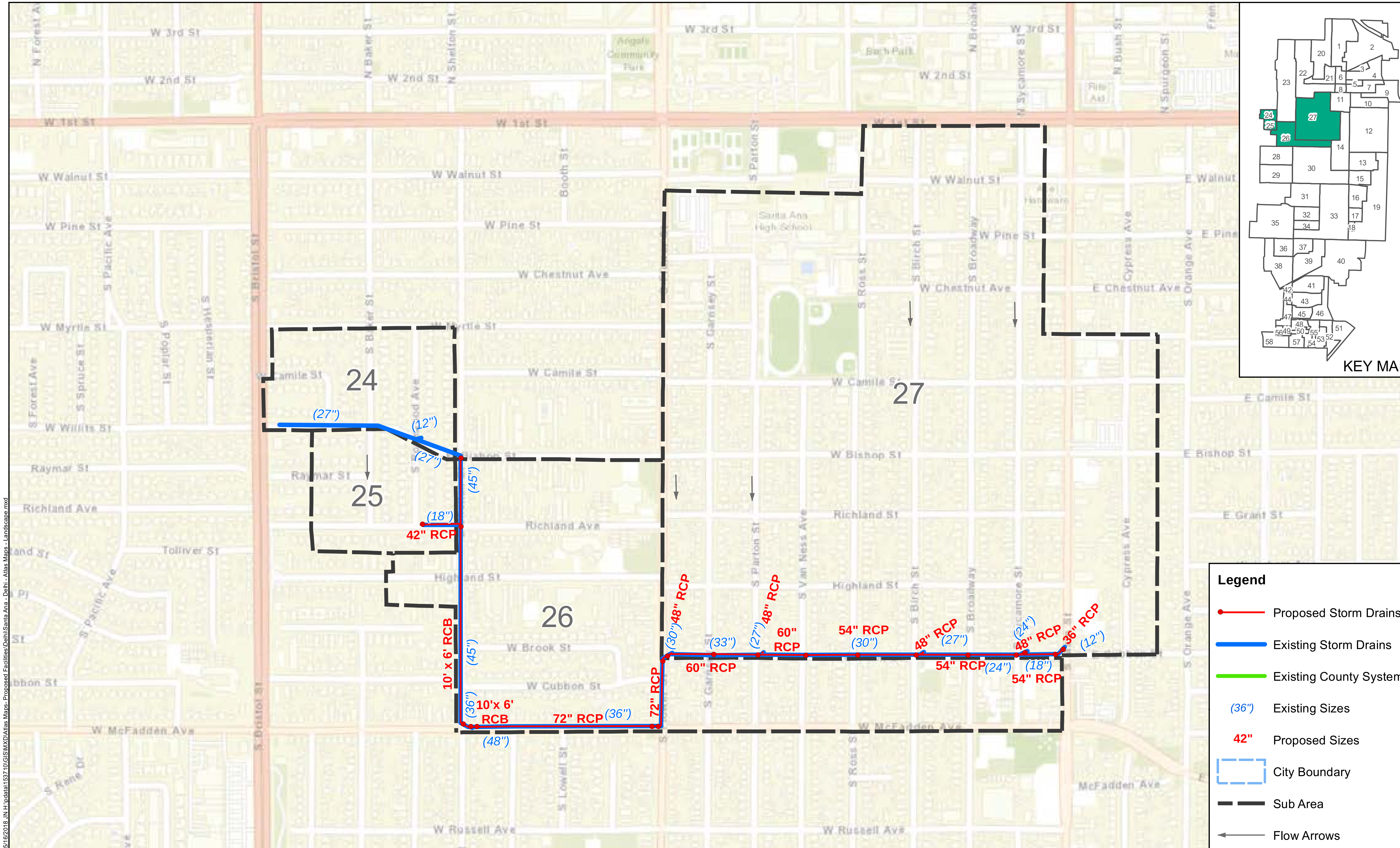


SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 20 - 23

FIGURE 4-17

5/16/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps- Proposed Facilities\Delhi\Santa Ana - Delhi - Atlas Maps - Portrait.mxd



Michael Baker INTERNATIONAL

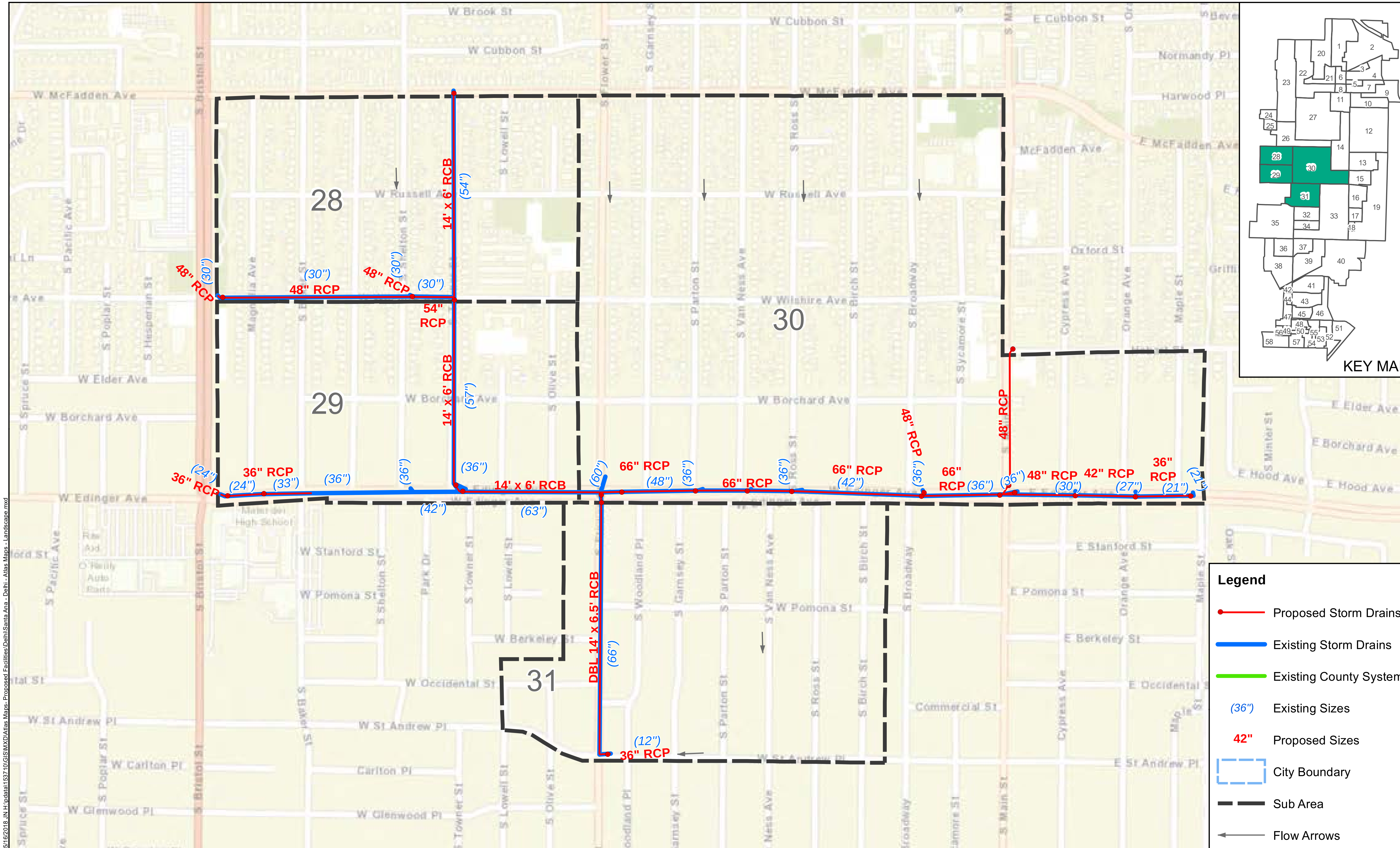
Source:

0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 24 - 27

FIGURE 4-18



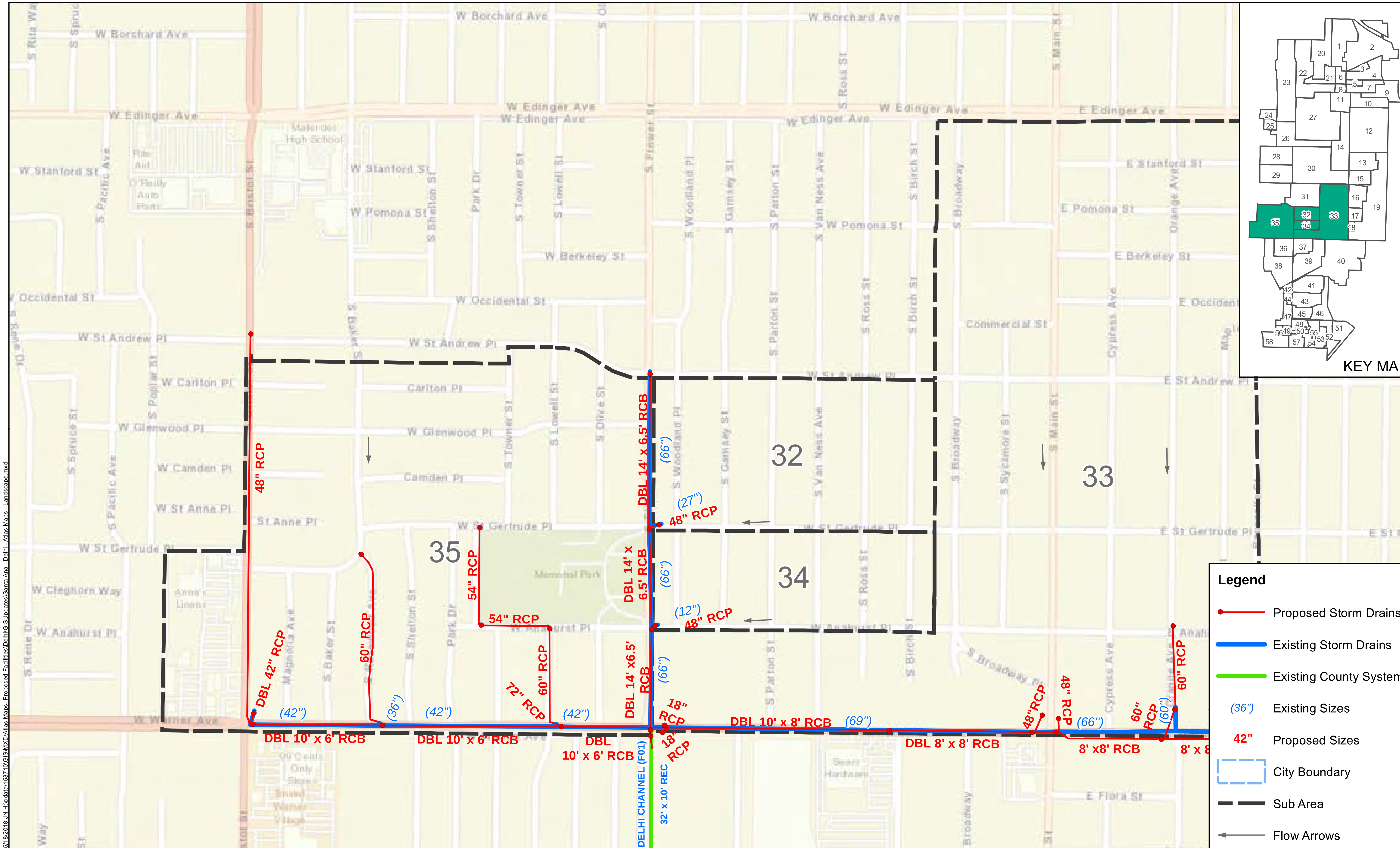
Michael Baker INTERNATIONAL

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 28 - 31

FIGURE 4-19



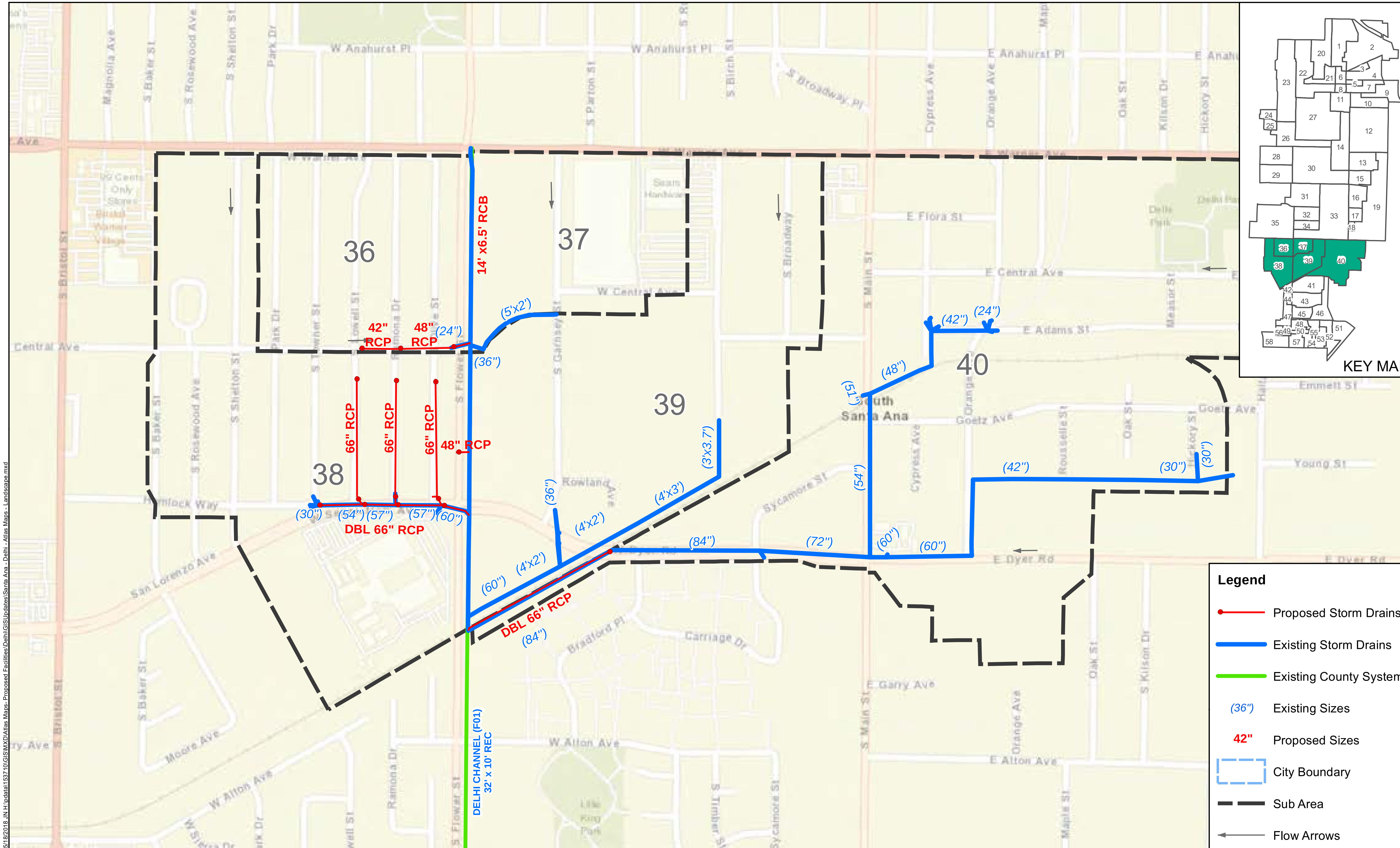
0 500 1,000 Feet

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 32 - 35

FIGURE 4-20



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Michael Baker INTERNATIONAL

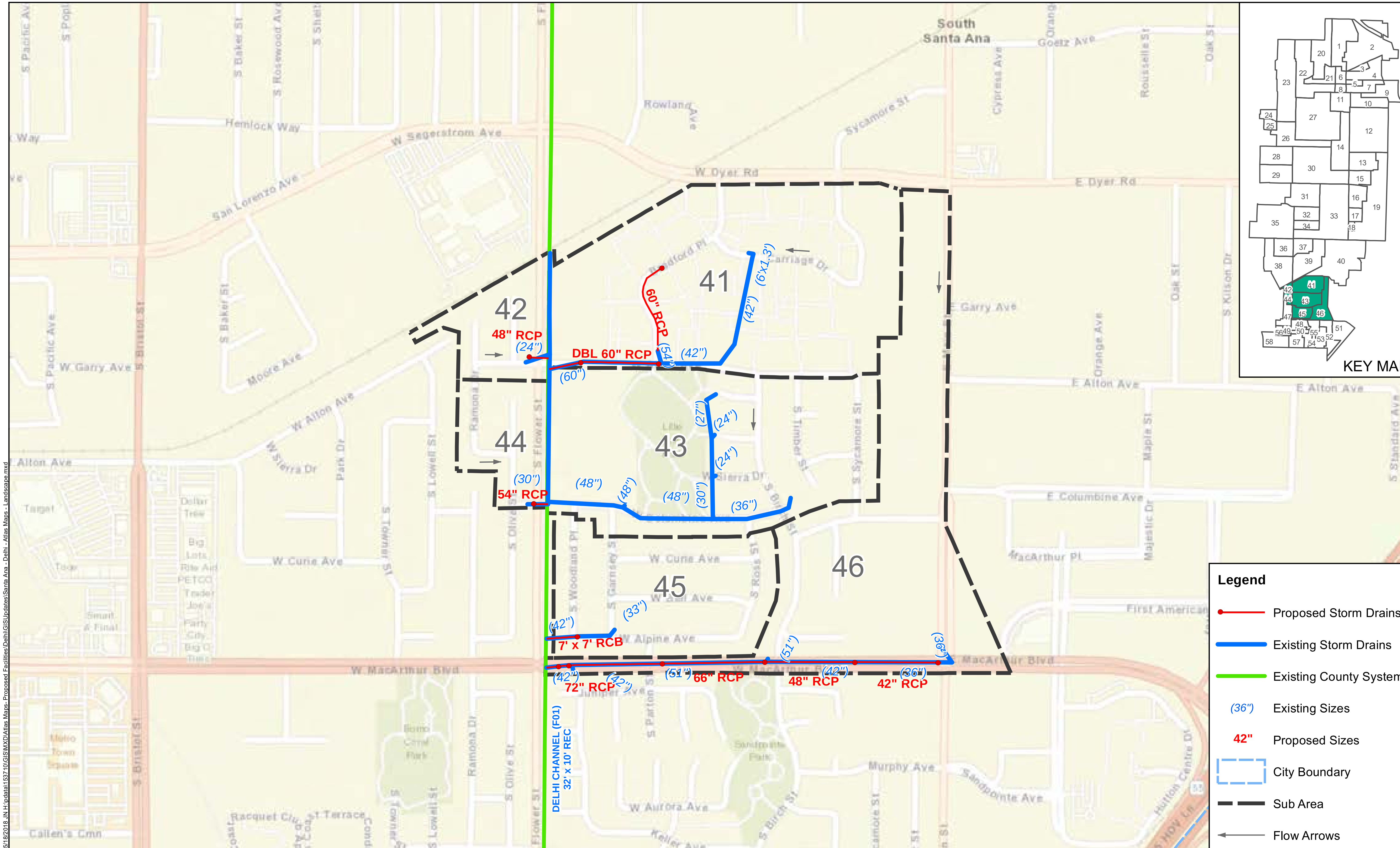
Source:

0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 36 - 40

FIGURE 4-21



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Michael Baker INTERNATIONAL

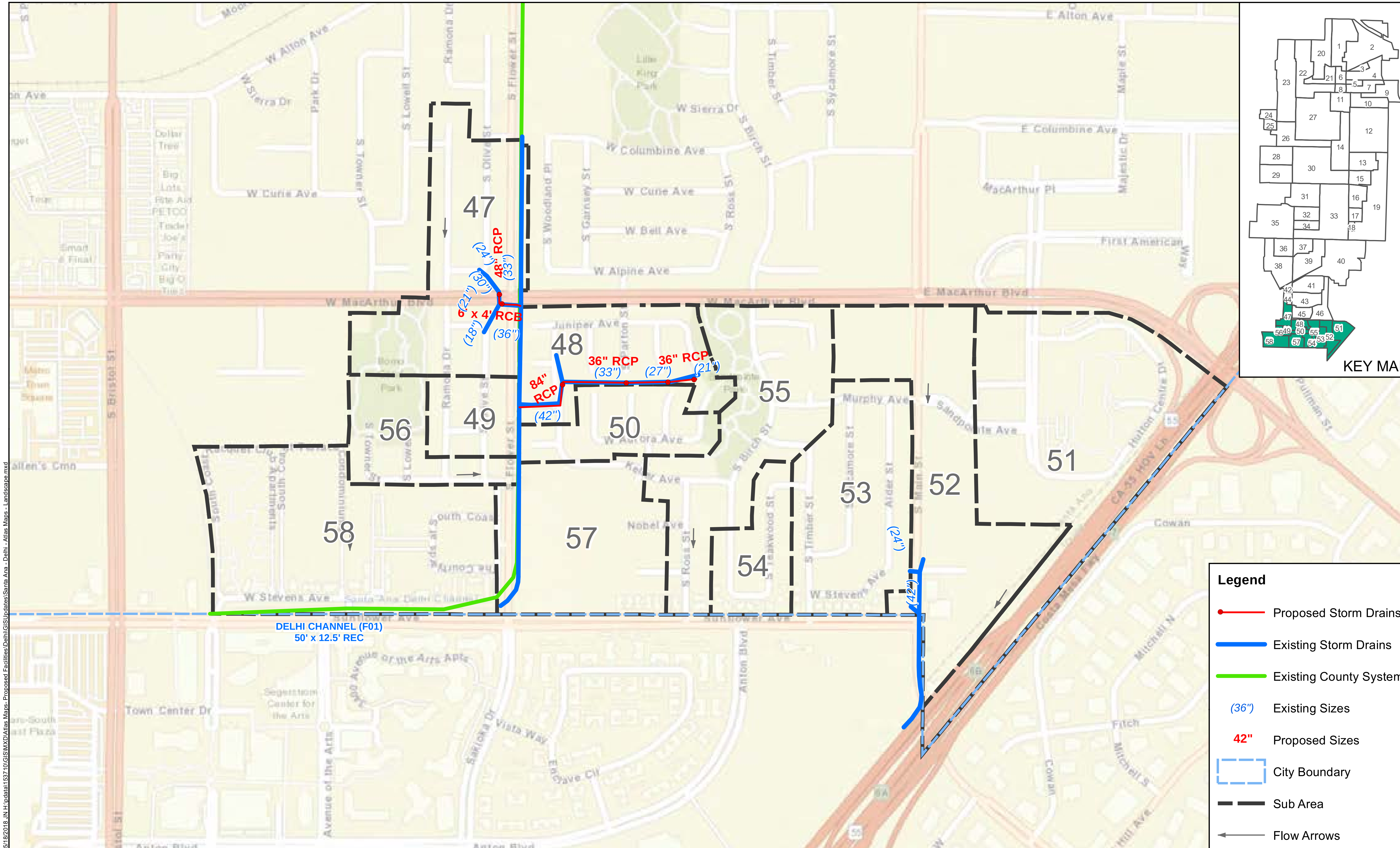
0 500 1,000 Feet

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 41 - 46

FIGURE 4-22



Michael Baker INTERNATIONAL

Source:

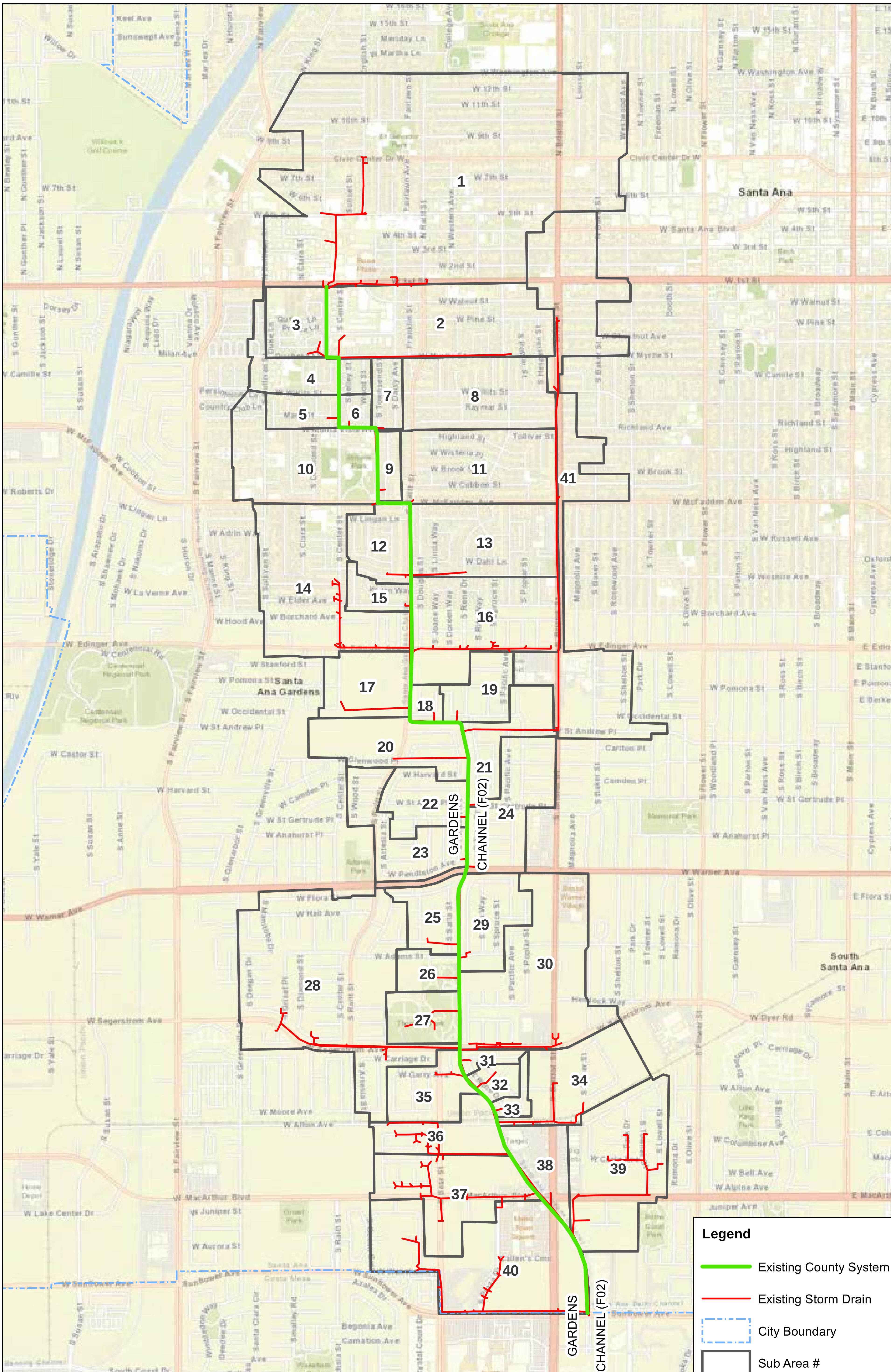
5/18/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps\Santa Ana - Delhi - Atlas Maps - Landscape.mxd

SANTA ANA MASTER PLAN OF DRAINAGE
DELHI WATERSHED

PROPOSED FACILITIES - SUB AREAS 47 - 58

FIGURE 4-23

GARDENS EXHIBITS



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Michael Baker INTERNATIONAL

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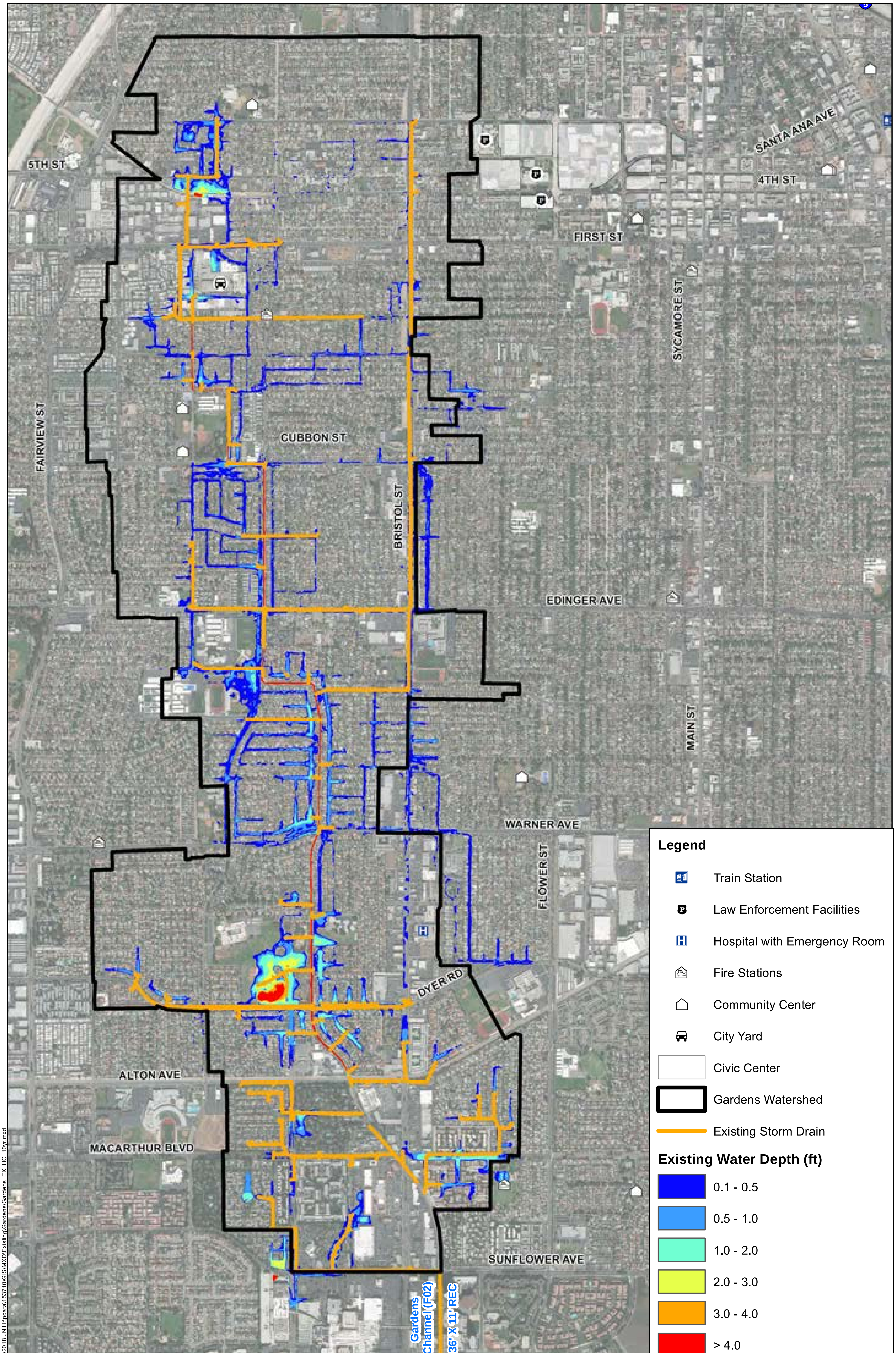
Source:

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed Sub Areas Exhibit

Figure 5-1



Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

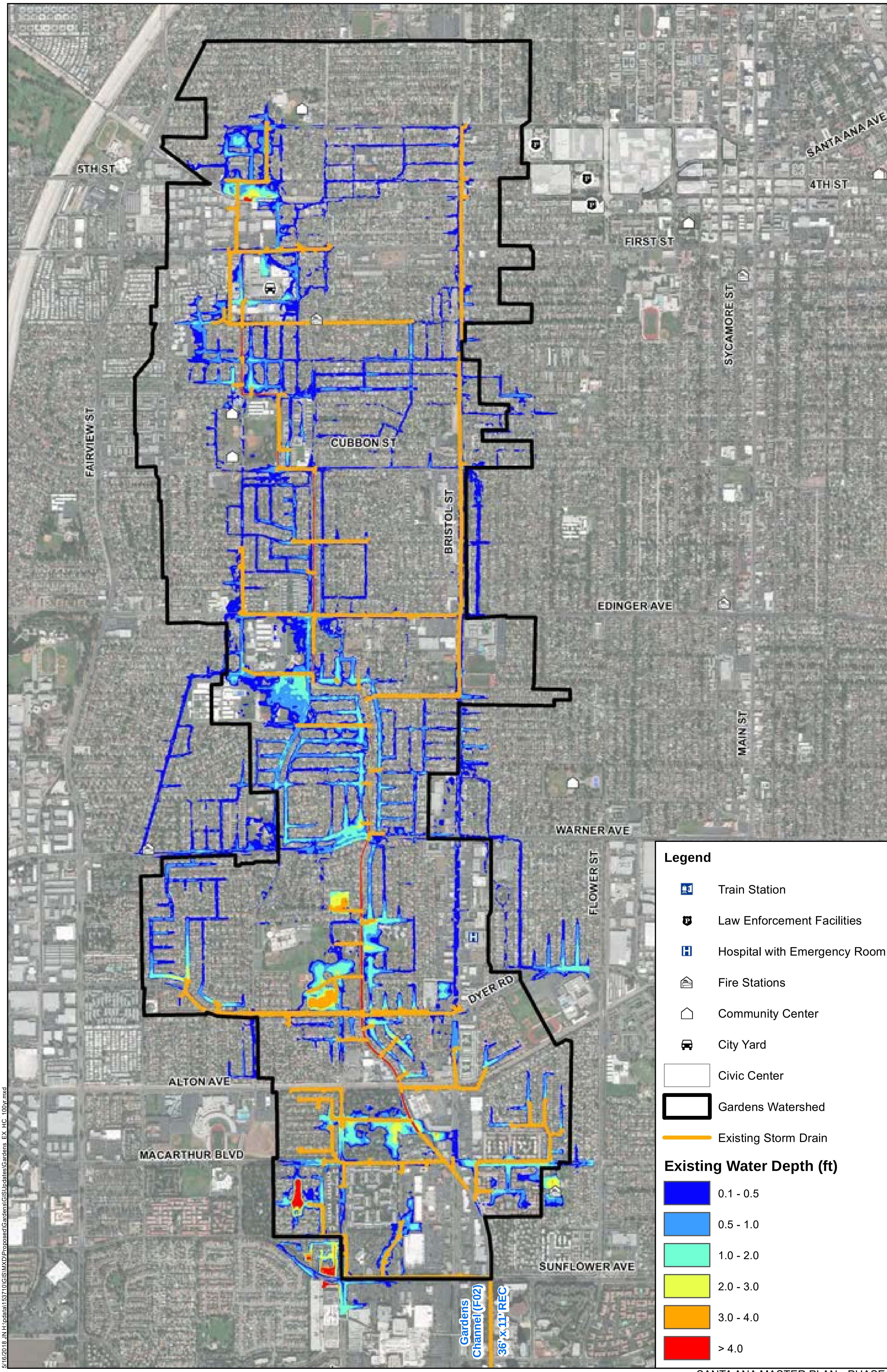
Source:

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - Maximum Flooded Depth Map

10- year Existing Condition

Figure 5-2



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Michael Baker INTERNATIONAL

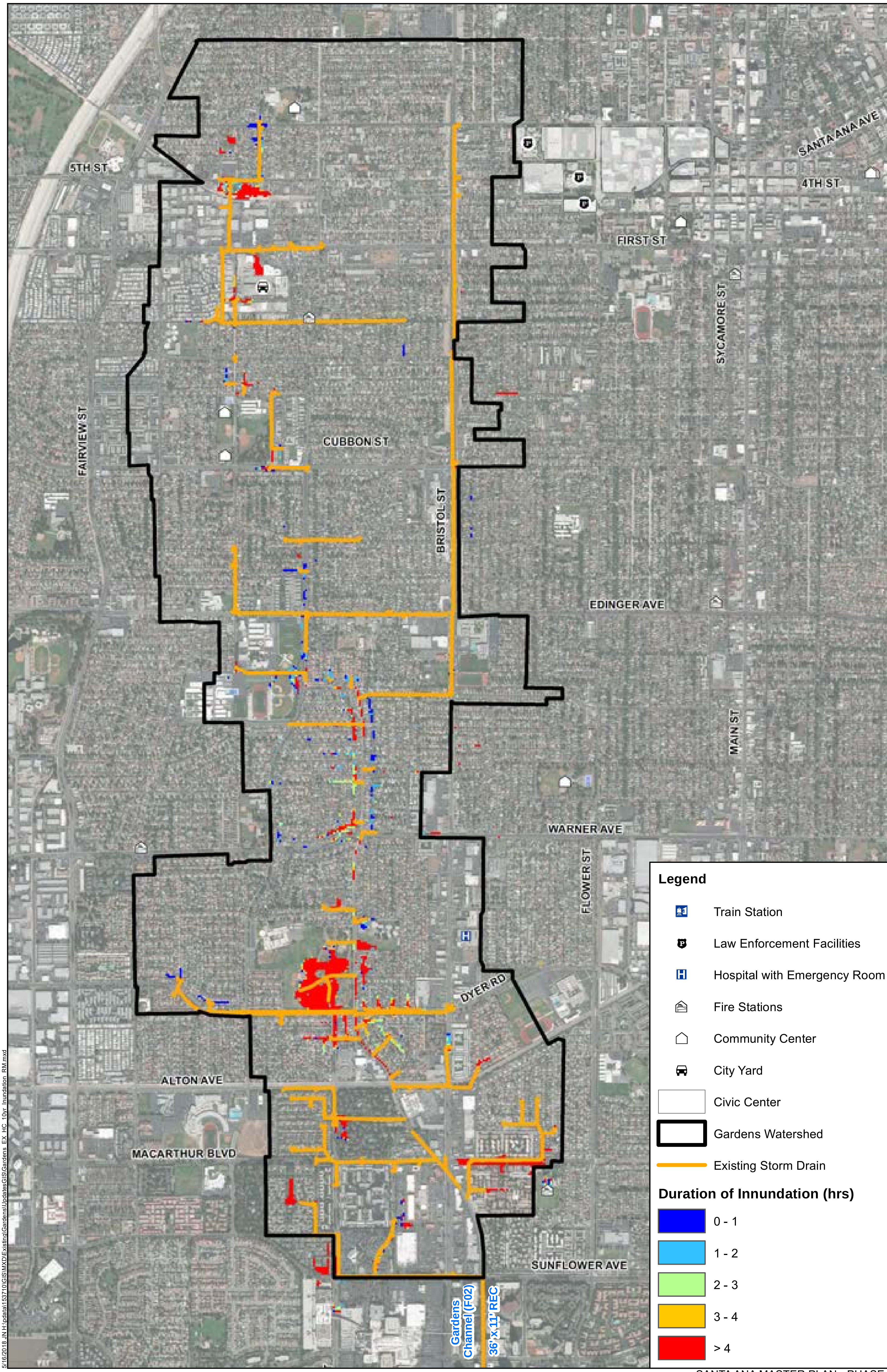
0 500 1,000 2,000 Feet

Source:

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - Maximum Flooded Depth Map
100- year Existing Condition

Figure 5-3



Michael Baker INTERNATIONAL

Source:

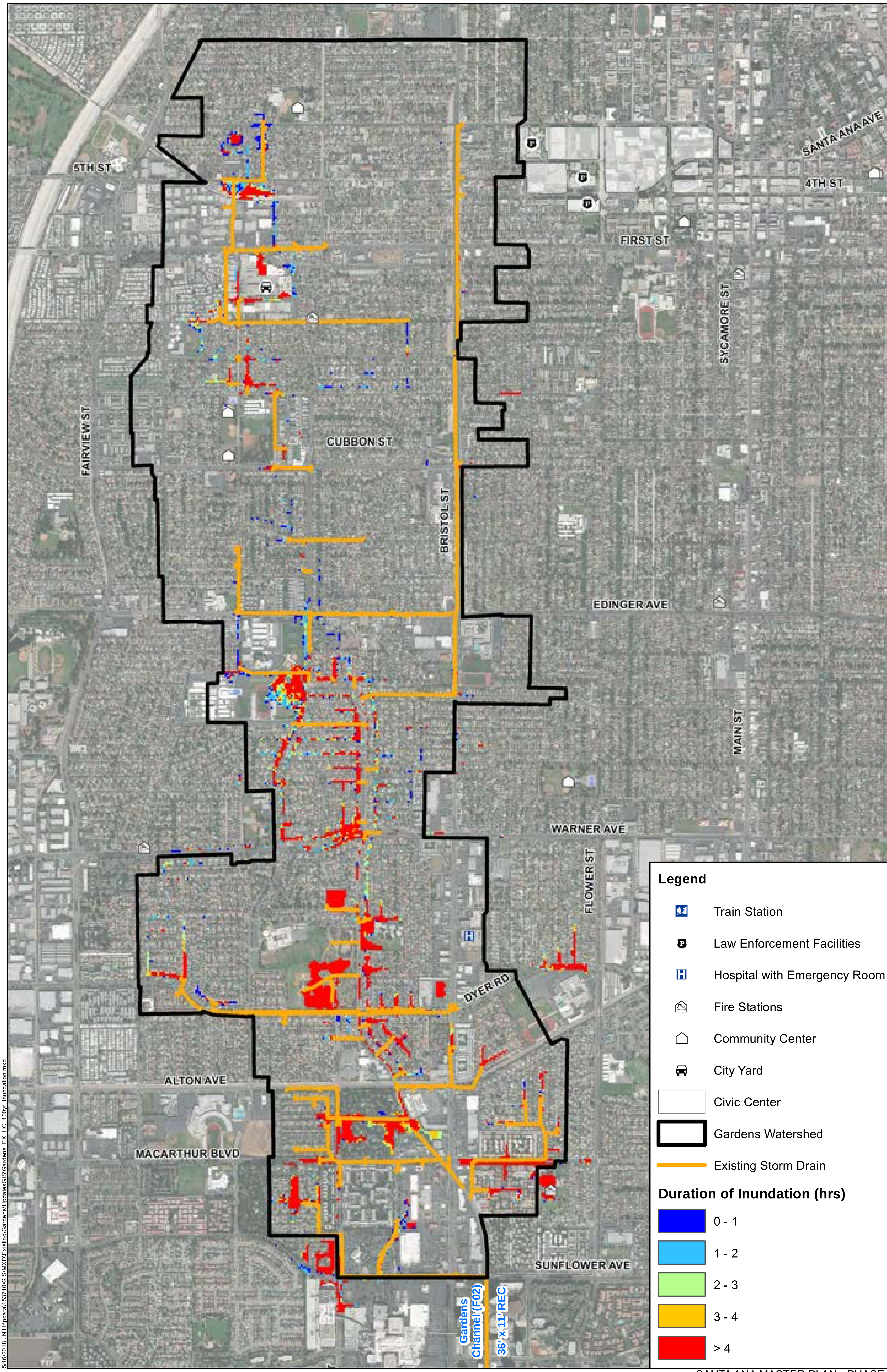
0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - Duration of Inundation Map

10- year Existing Condition

Figure 5-4



Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

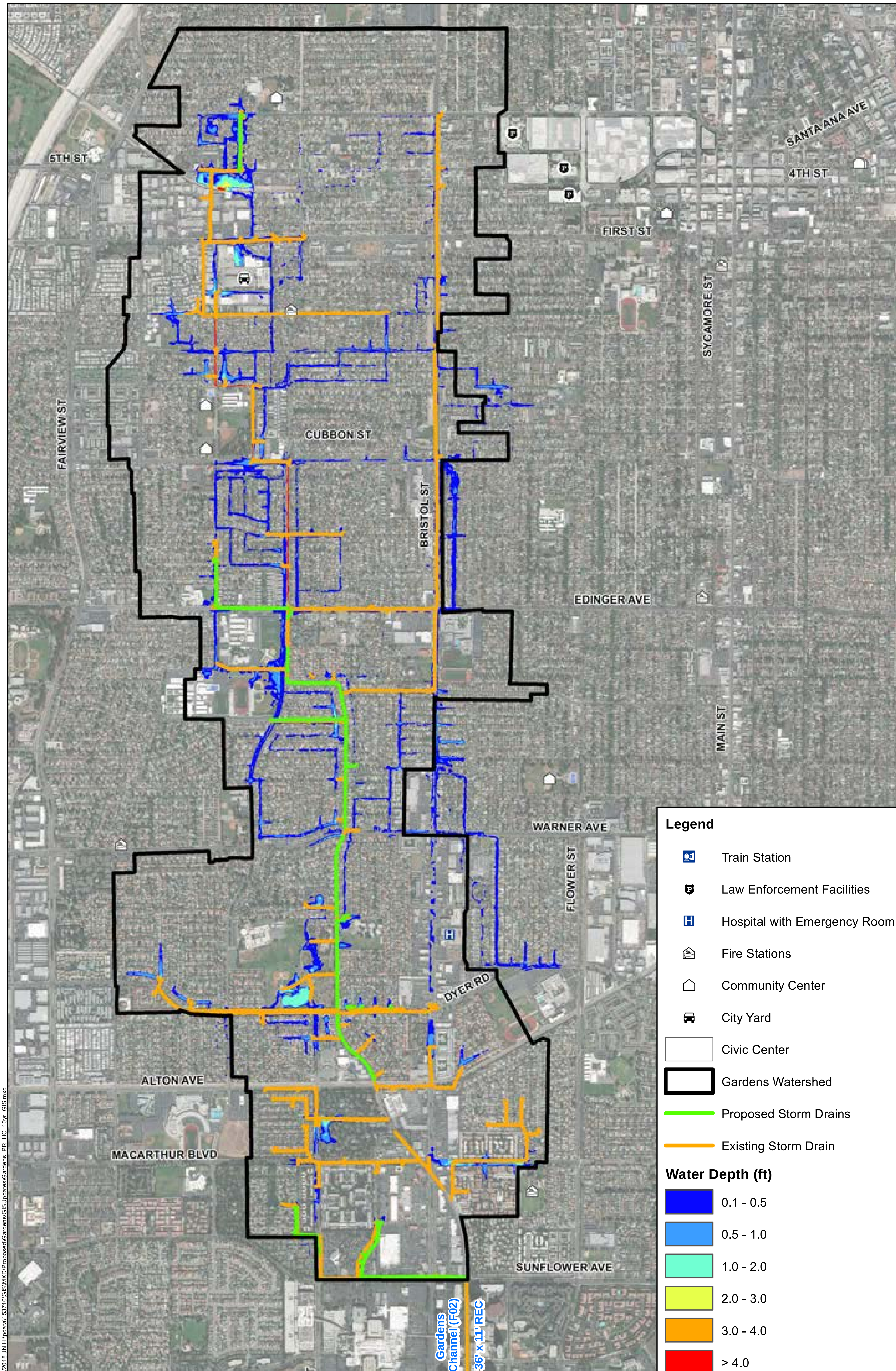
Source:

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - Duration of Inundation Map

100- year Existing Condition

Figure 5-5



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Michael Baker INTERNATIONAL

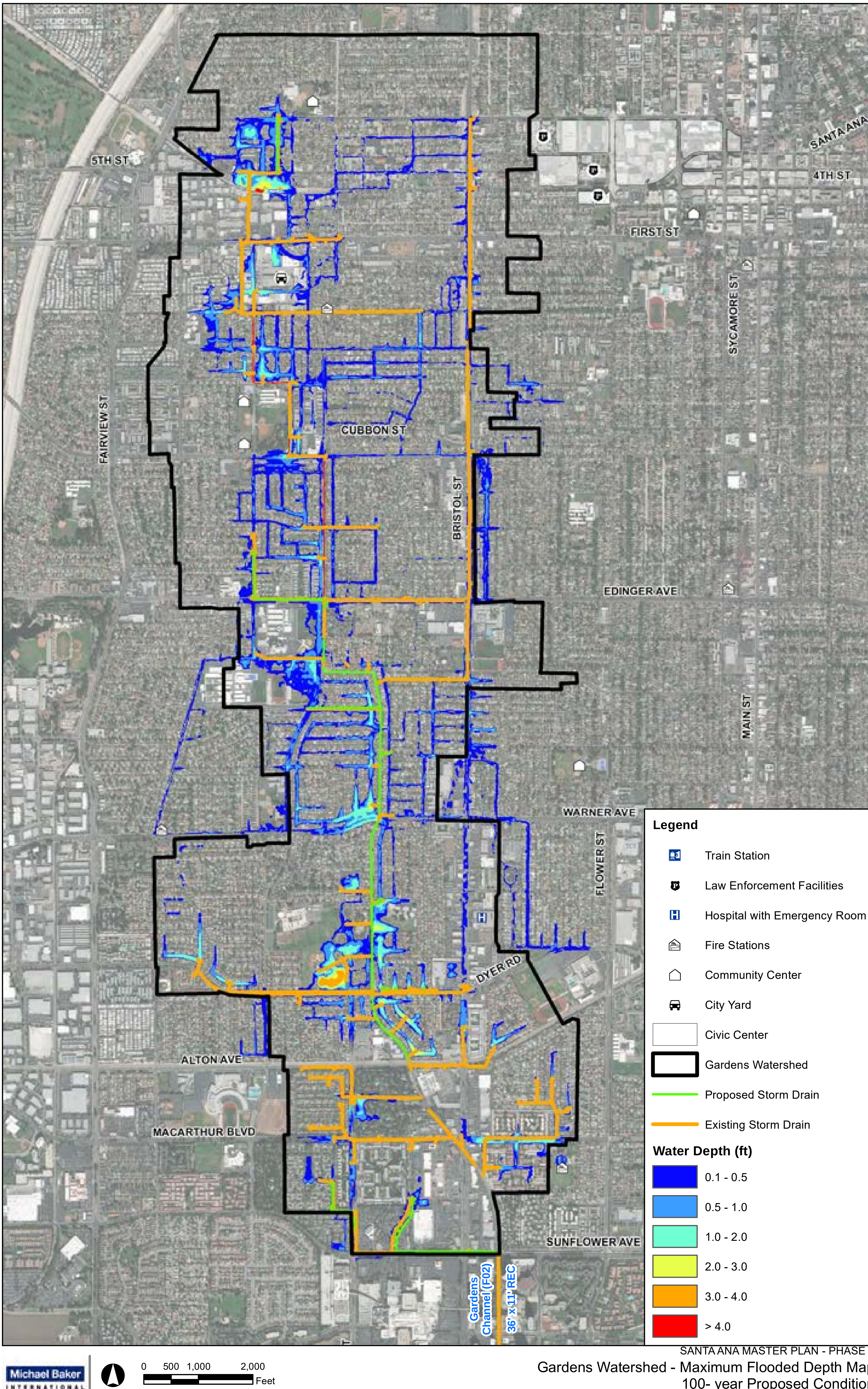
0 500 1,000 2,000 Feet

Source:

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - Maximum Flooded Depth Map
10- year Proposed Condition

Figure 5-6



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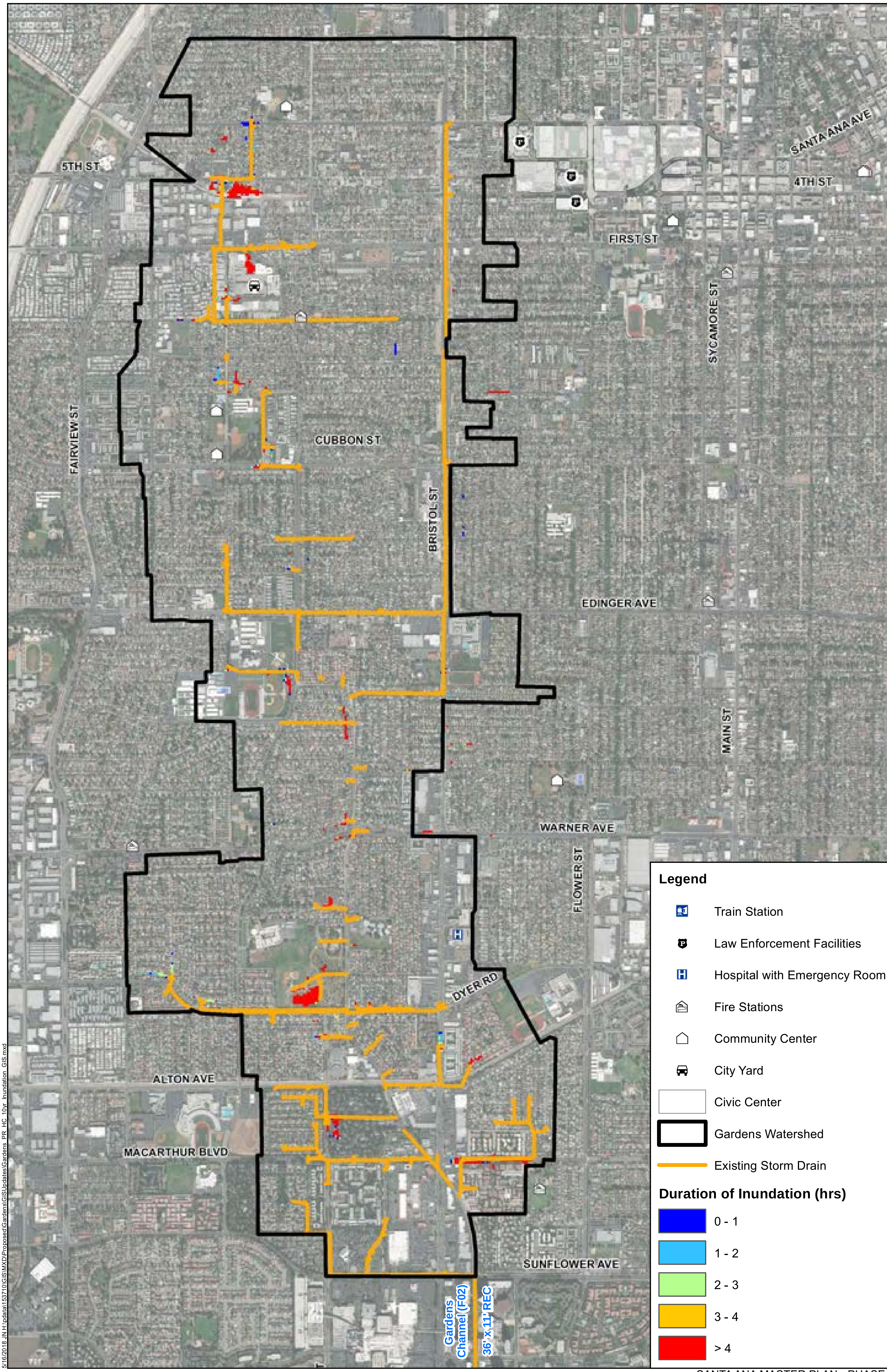
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - Maximum Flooded Depth Map
100- year Proposed Condition

Figure 5-7



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Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

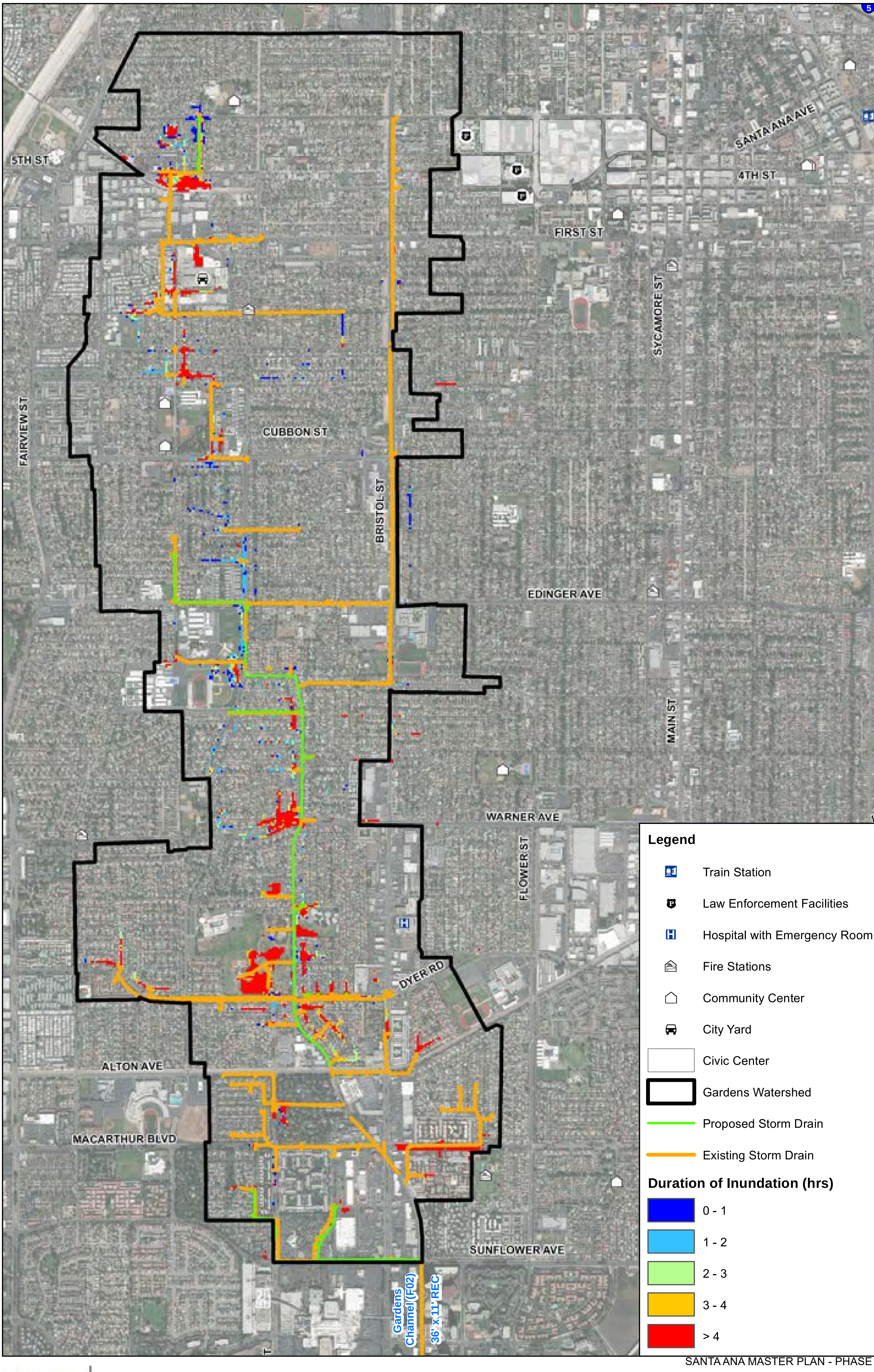
Source:

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - Duration of Inundation Map

10- year Proposed Condition

Figure 5-8



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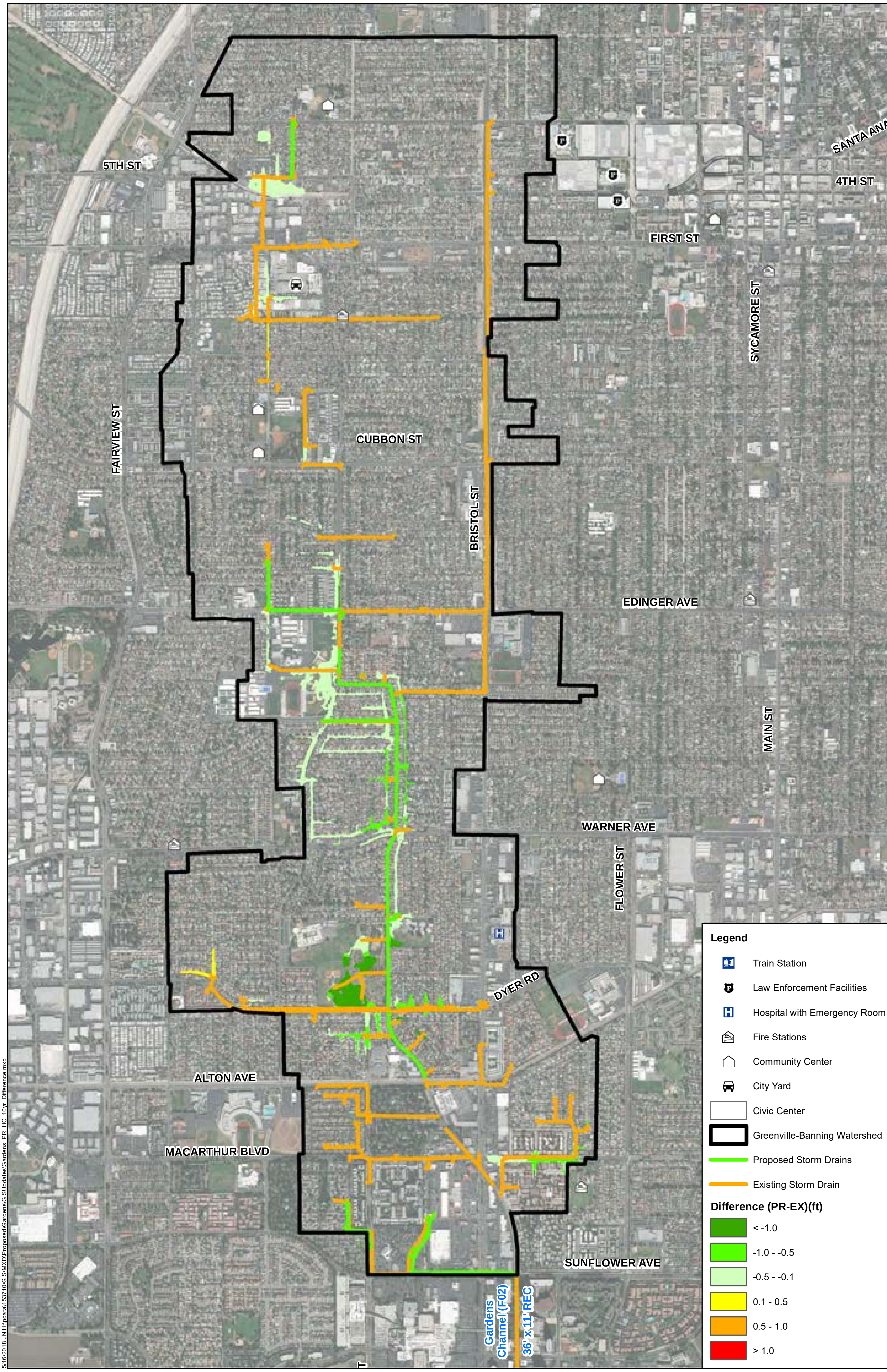
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - Duration of Inundation Map
100- year Proposed Condition

Figure 5-9



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Michael Baker INTERNATIONAL

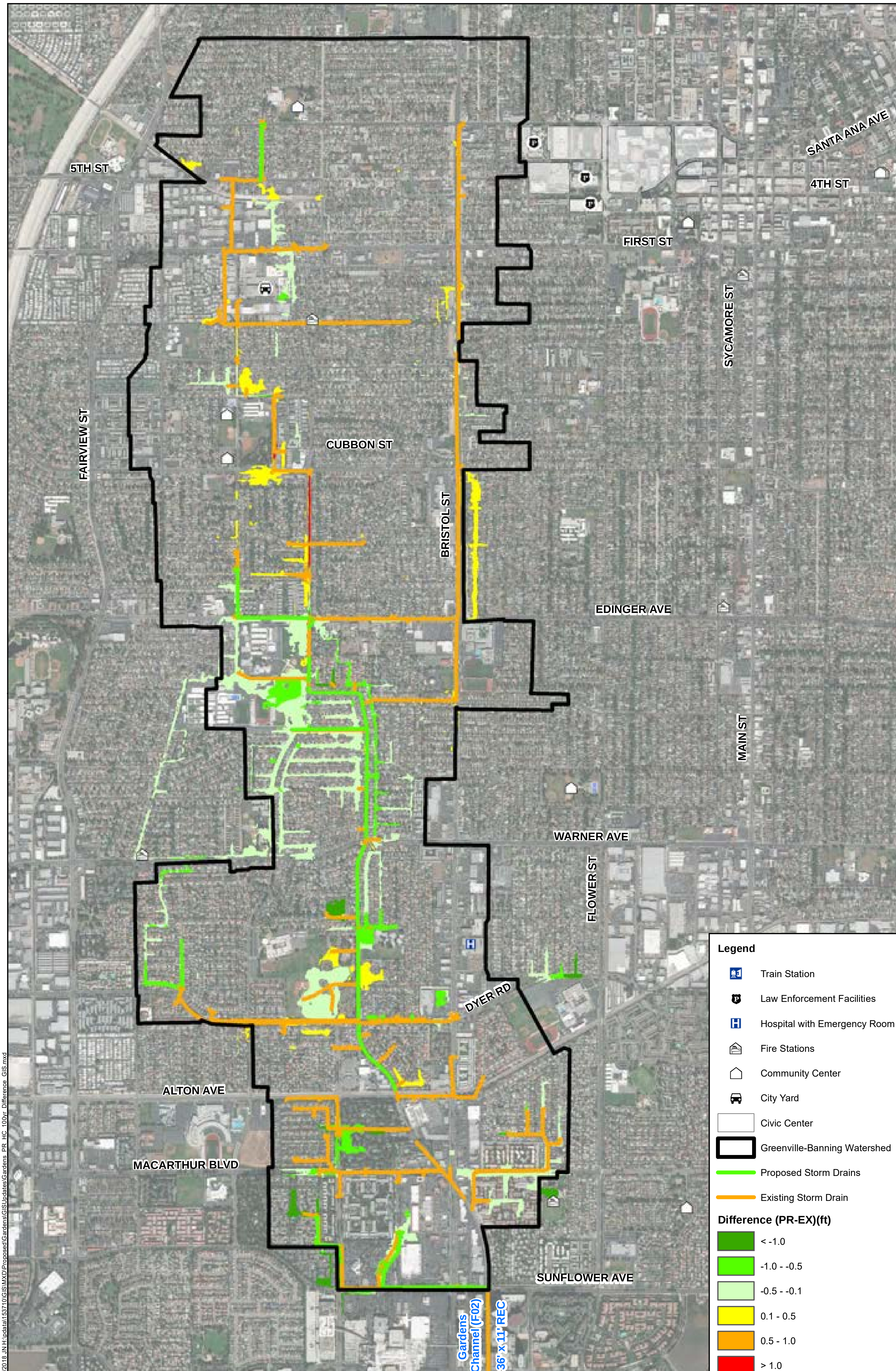
0 500 1,000 2,000 Feet

Source:

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - 10- year Difference Map

Figure 5-10



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Michael Baker INTERNATIONAL

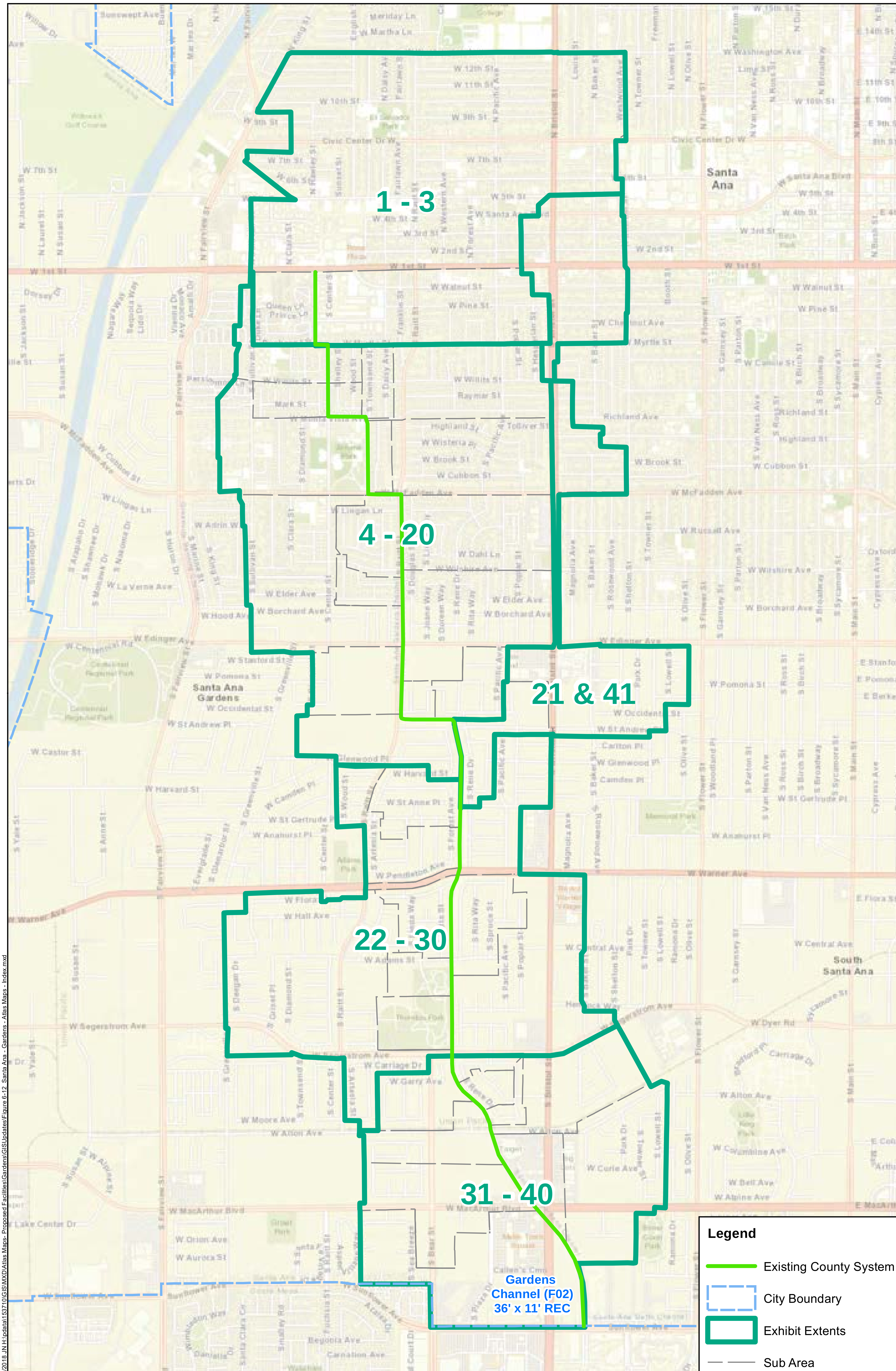
0 500 1,000 2,000 Feet

Source:

SANTA ANA MASTER PLAN - PHASE 2

Gardens Watershed - 100- year Difference Map

Figure 5-11



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Feet

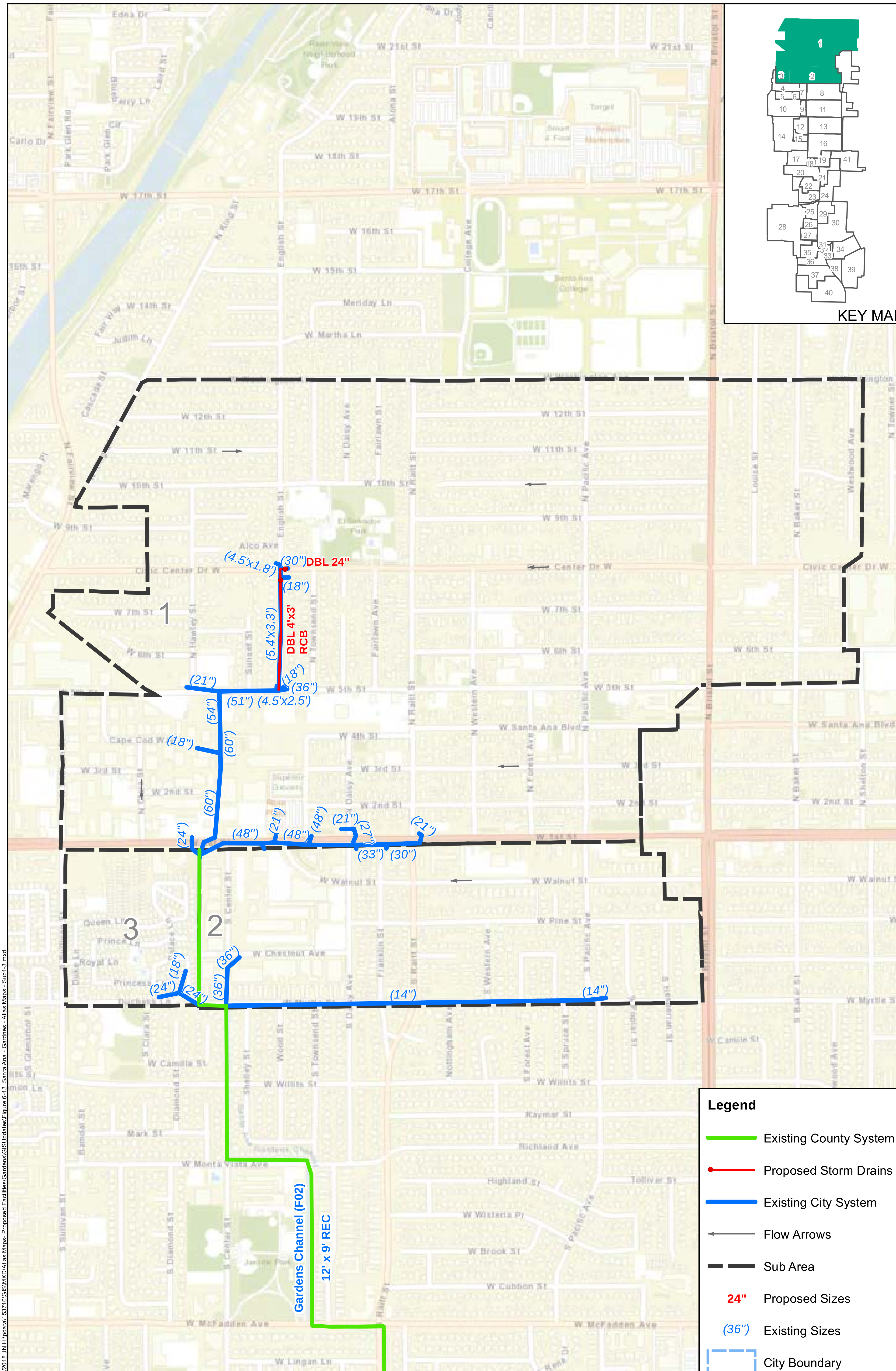
Michael Baker INTERNATIONAL

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
GARDENS WATERSHED

Proposed Facilities - Exhibit Extents Index Map

Figure 5-12



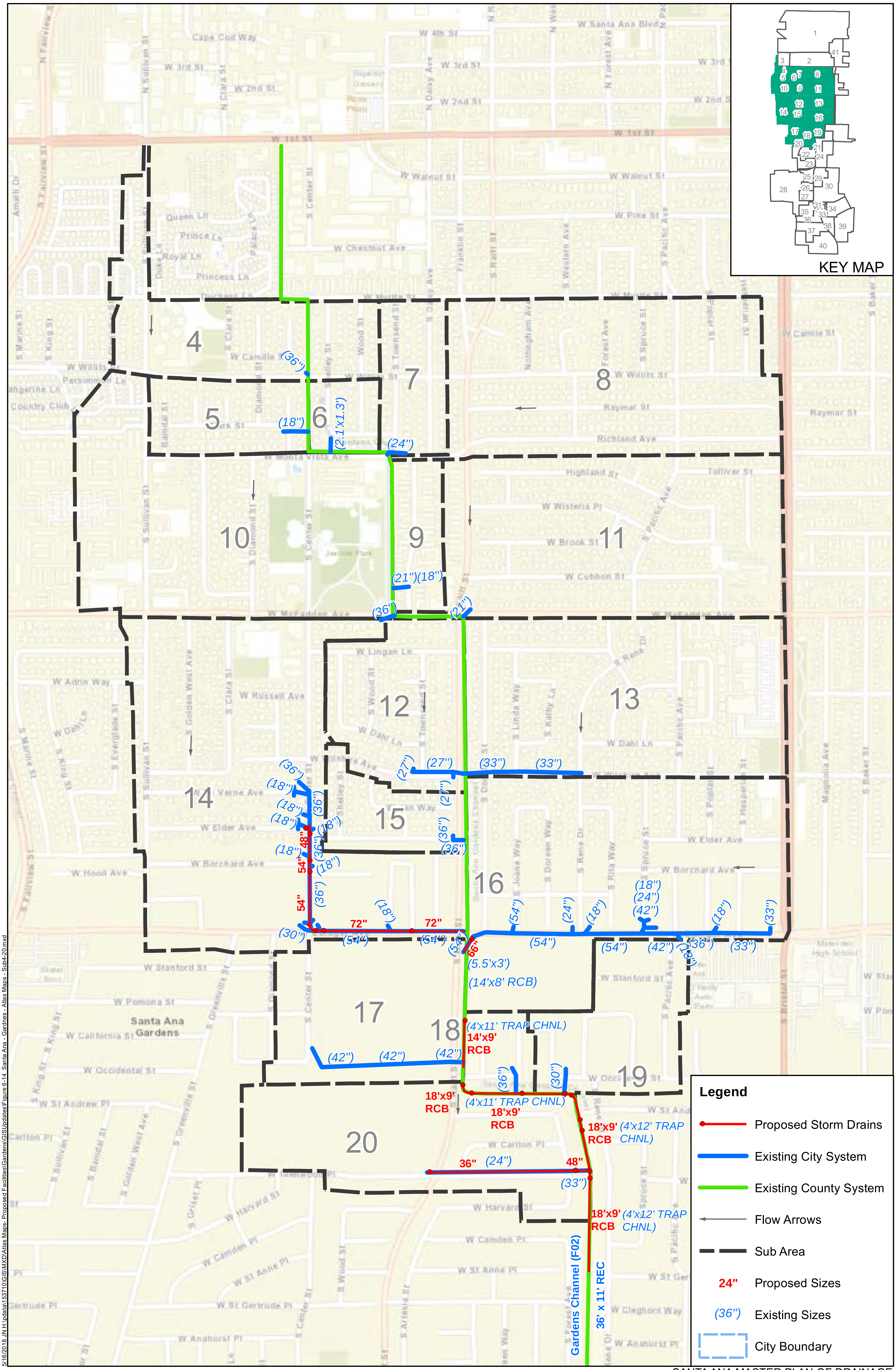
0 500 1,000 Feet

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
GARDENS WATERSHED

Proposed Facilities - Sub Area 1 - 3

Figure 5-13



5/16/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps- Proposed Facilities\Gardens\GIS\Updates\Figure 6-14 Santa Ana - Gardnes - Atlas Maps - Sub4-20.mxd

Michael Baker INTERNATIONAL

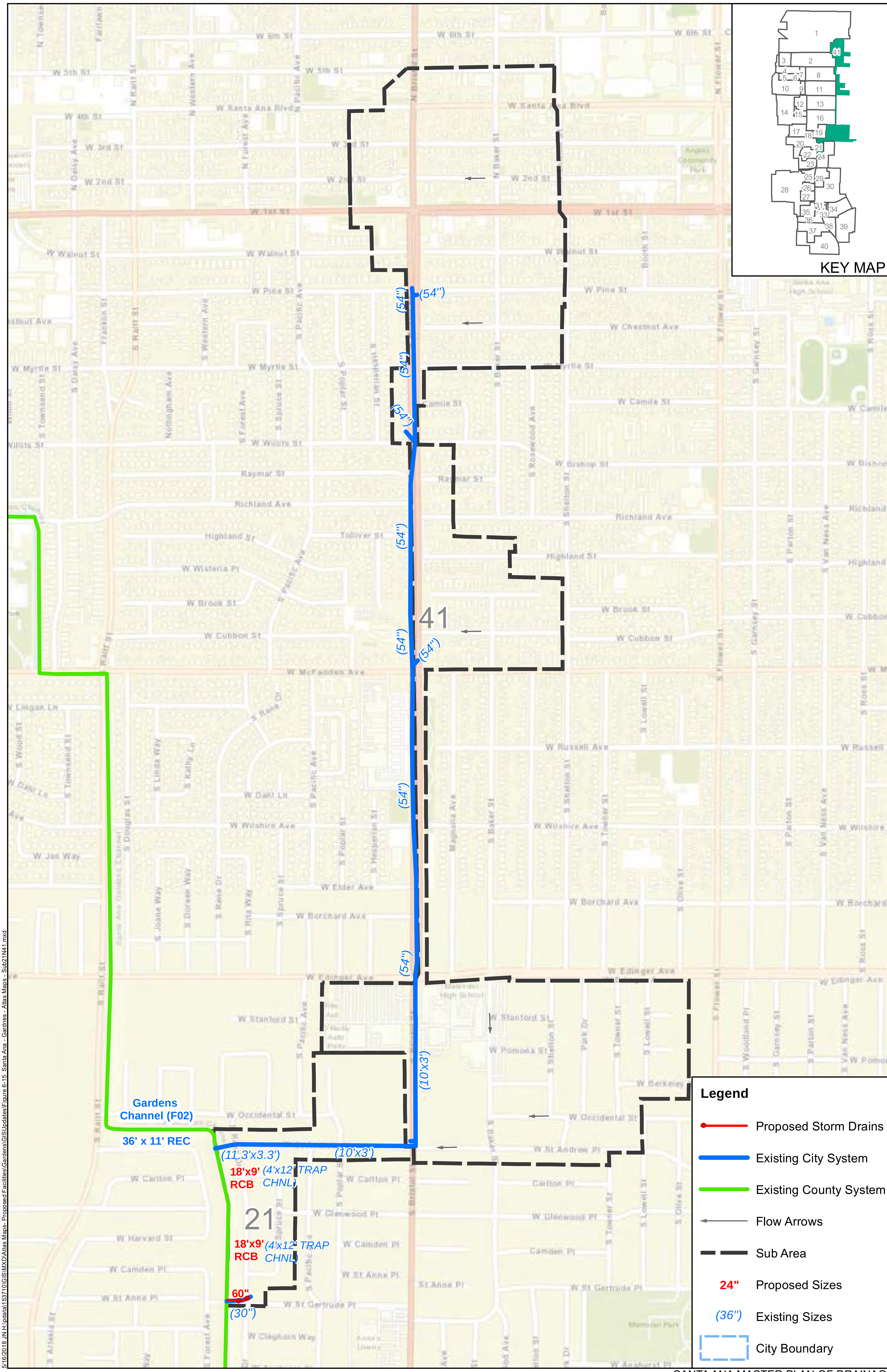
Source:

0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
GARDENS WATERSHED

Proposed Facilities - Sub Area 4 - 20

Figure 5-14



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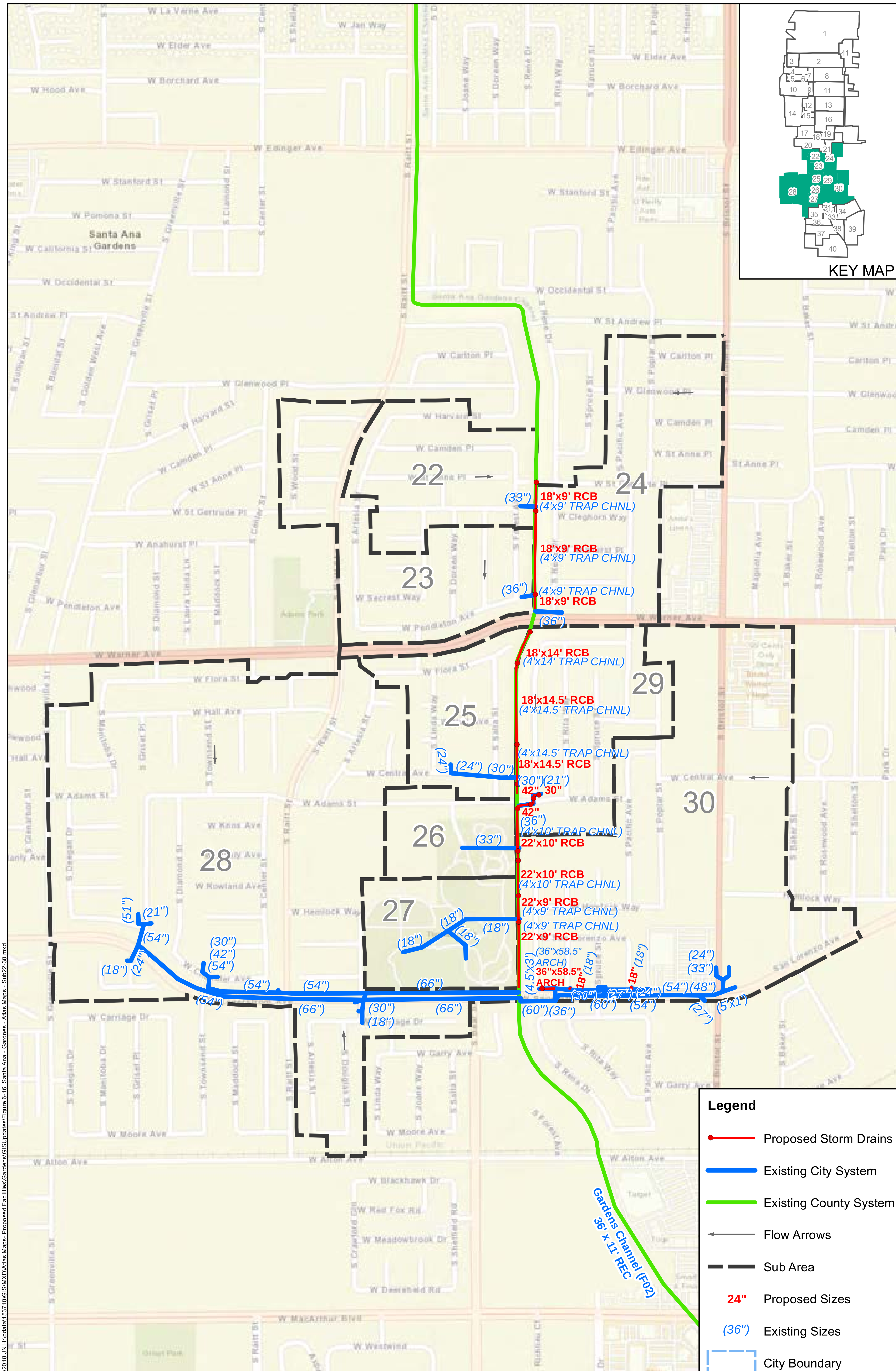
Feet

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
GARDENS WATERSHED

Proposed Facilities - Sub Area 21 & 41

Figure 5-15



5/16/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps- Proposed Facilities\Gardens\GIS\Updates\Figure 6-16 Santa Ana - Gardens - Atlas Maps - Sub22-30.mxd

Michael Baker INTERNATIONAL

Source:

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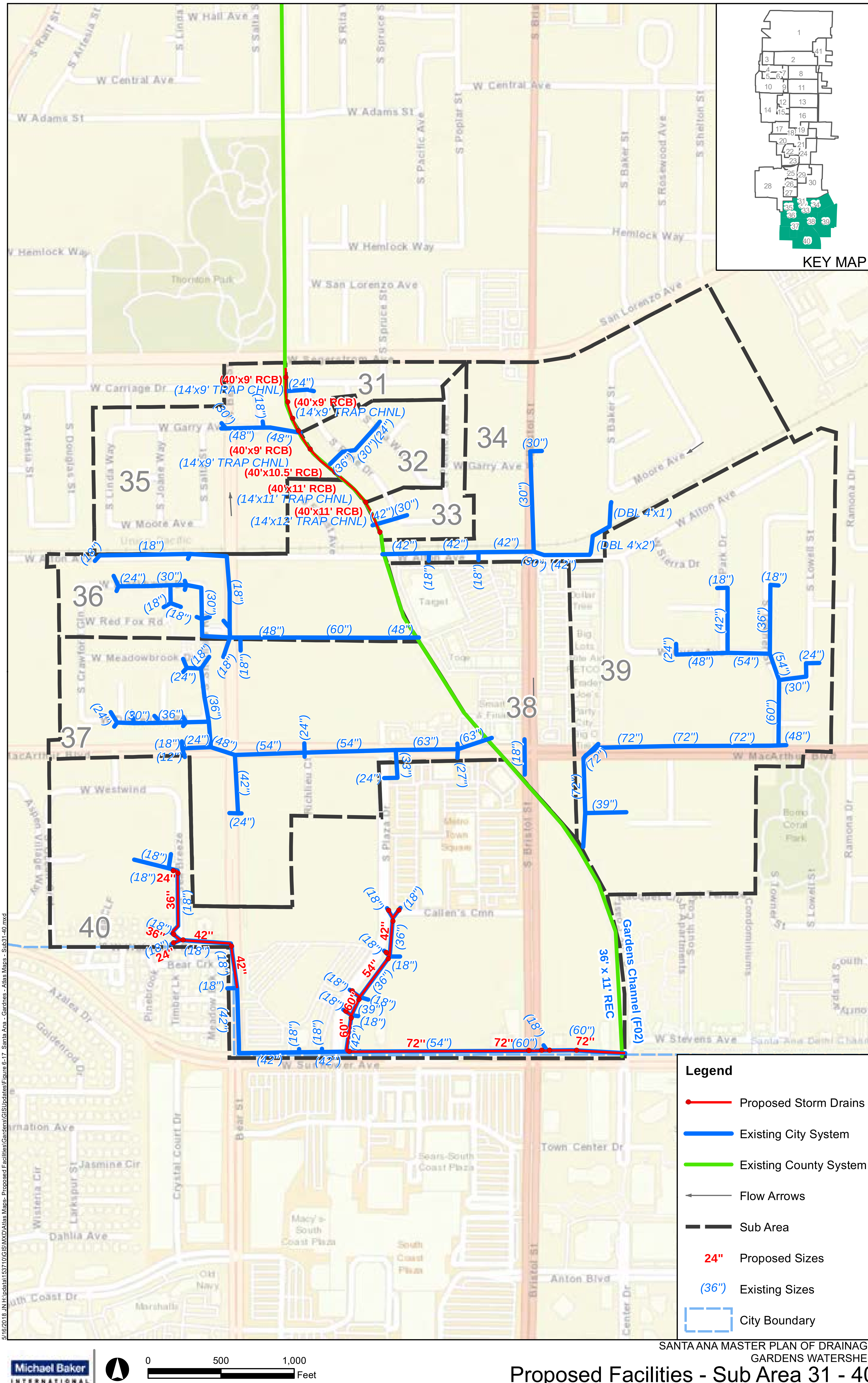
SANTA ANA MASTER PLAN OF DRAINAGE
GARDENS WATERSHED

Proposed Facilities - Sub Area 22 - 30

Figure 5-16



Michael Baker INTERNATIONAL

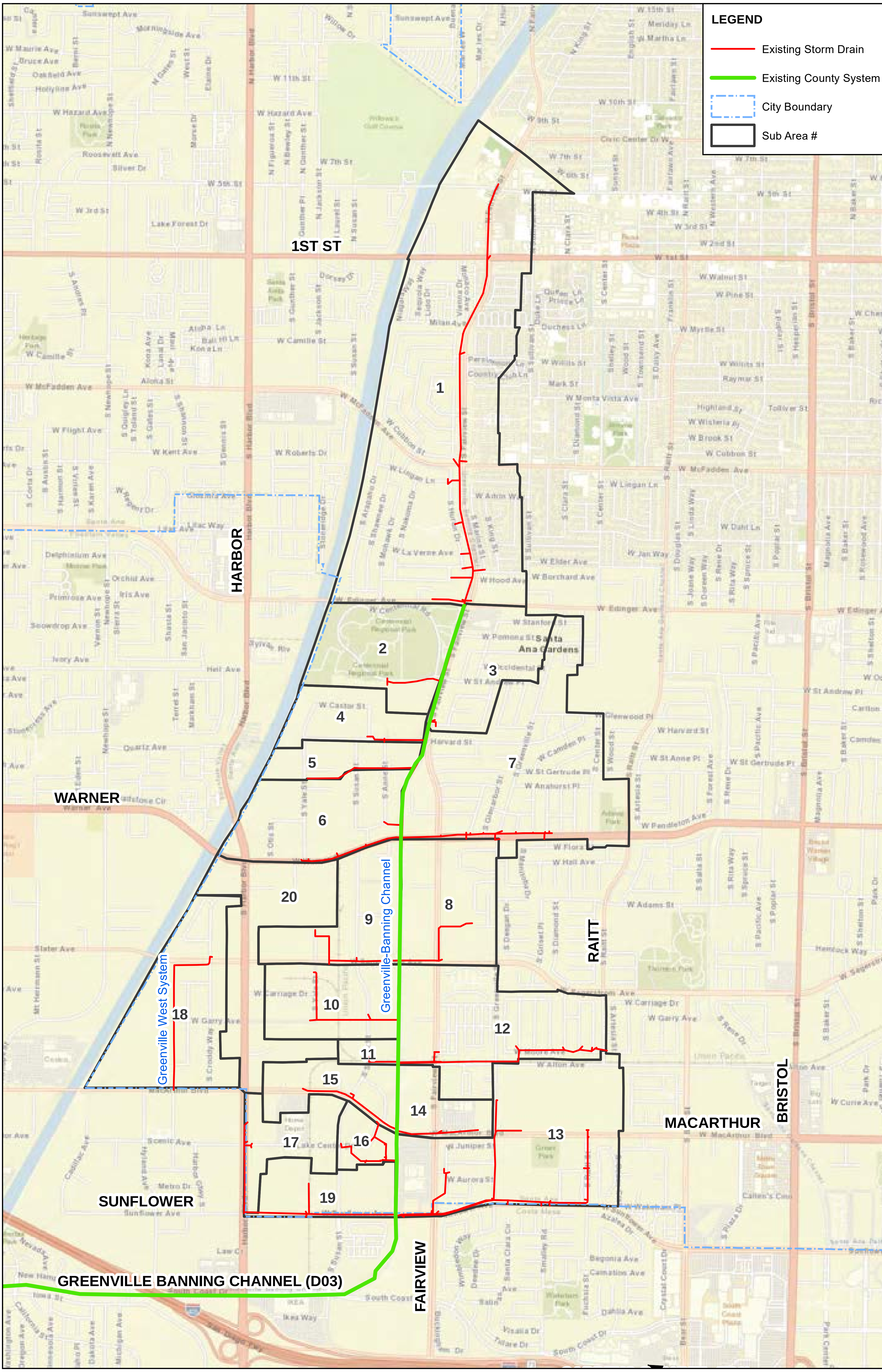
5/16/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps- Proposed Facilities\Gardens\GISUpdates\Figure 6-17 Santa Ana - Gardnes - Atlas Maps - Sub31-40.mxd

SANTA ANA MASTER PLAN OF DRAINAGE
GARDENS WATERSHED

Proposed Facilities - Sub Area 31 - 40

Figure 5-17

GREENVILLE BANNING EXHIBITS



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Michael Baker INTERNATIONAL

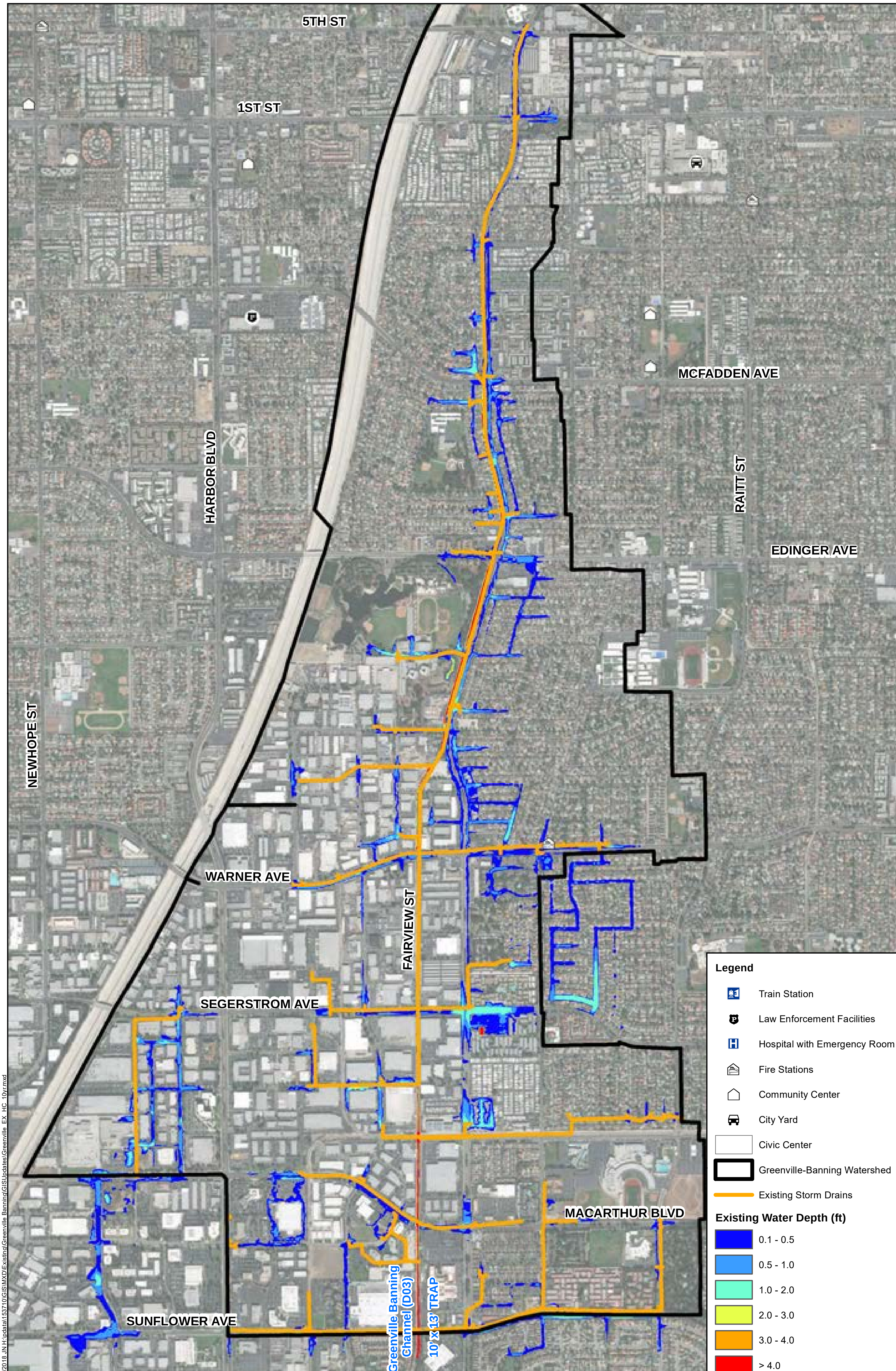
N

0 2,000 4,000 Feet

Source: Streets Basemap - Esri

SANTA ANA MASTER PLAN OF DRAINAGE
GREENVILLE BANNING WATERSHED
Watershed Subarea Map

FIGURE 6-1



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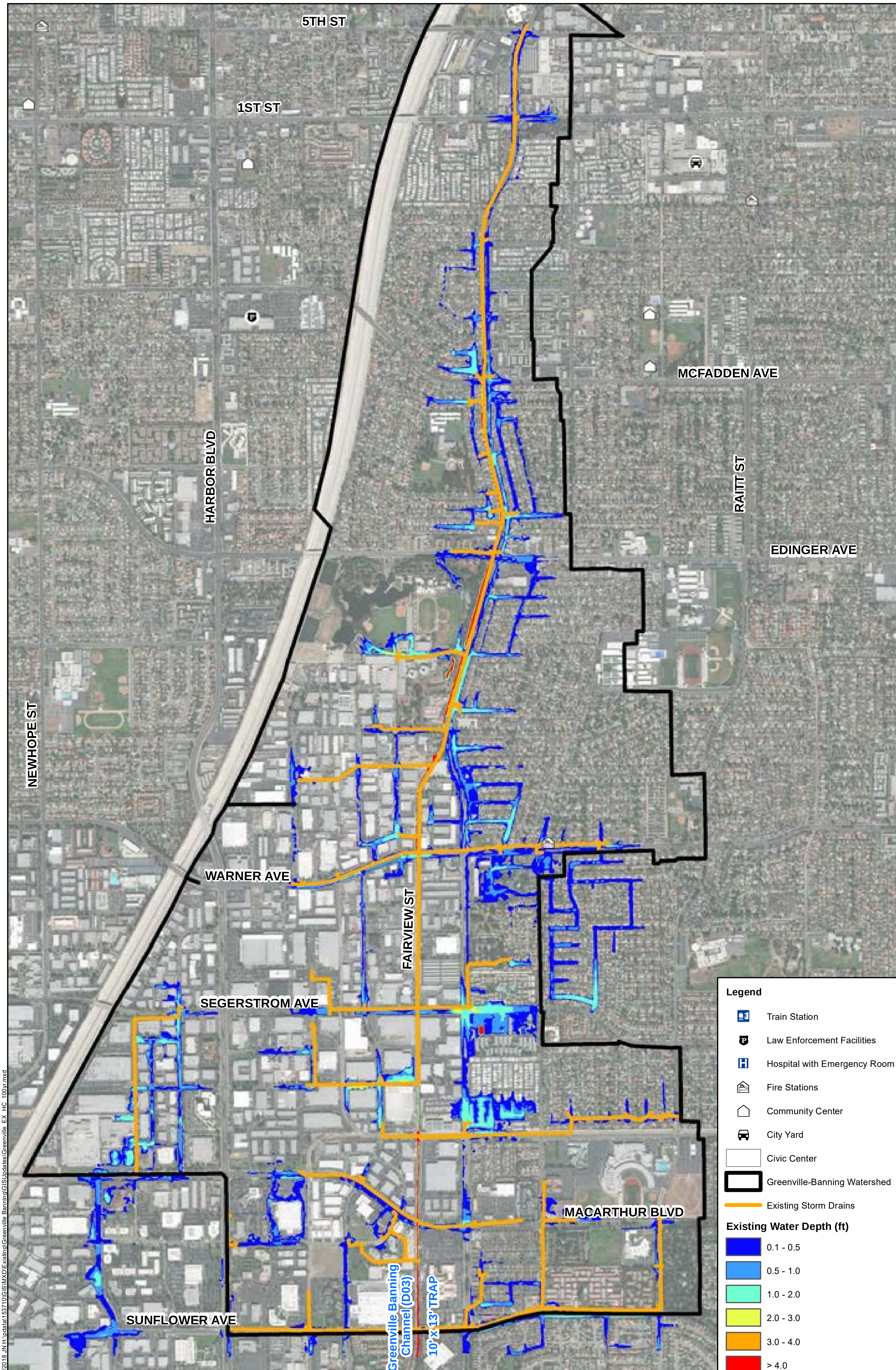
SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed - Maximum Flooded Depth Map

10- year Existing Condition

Figure 6-2



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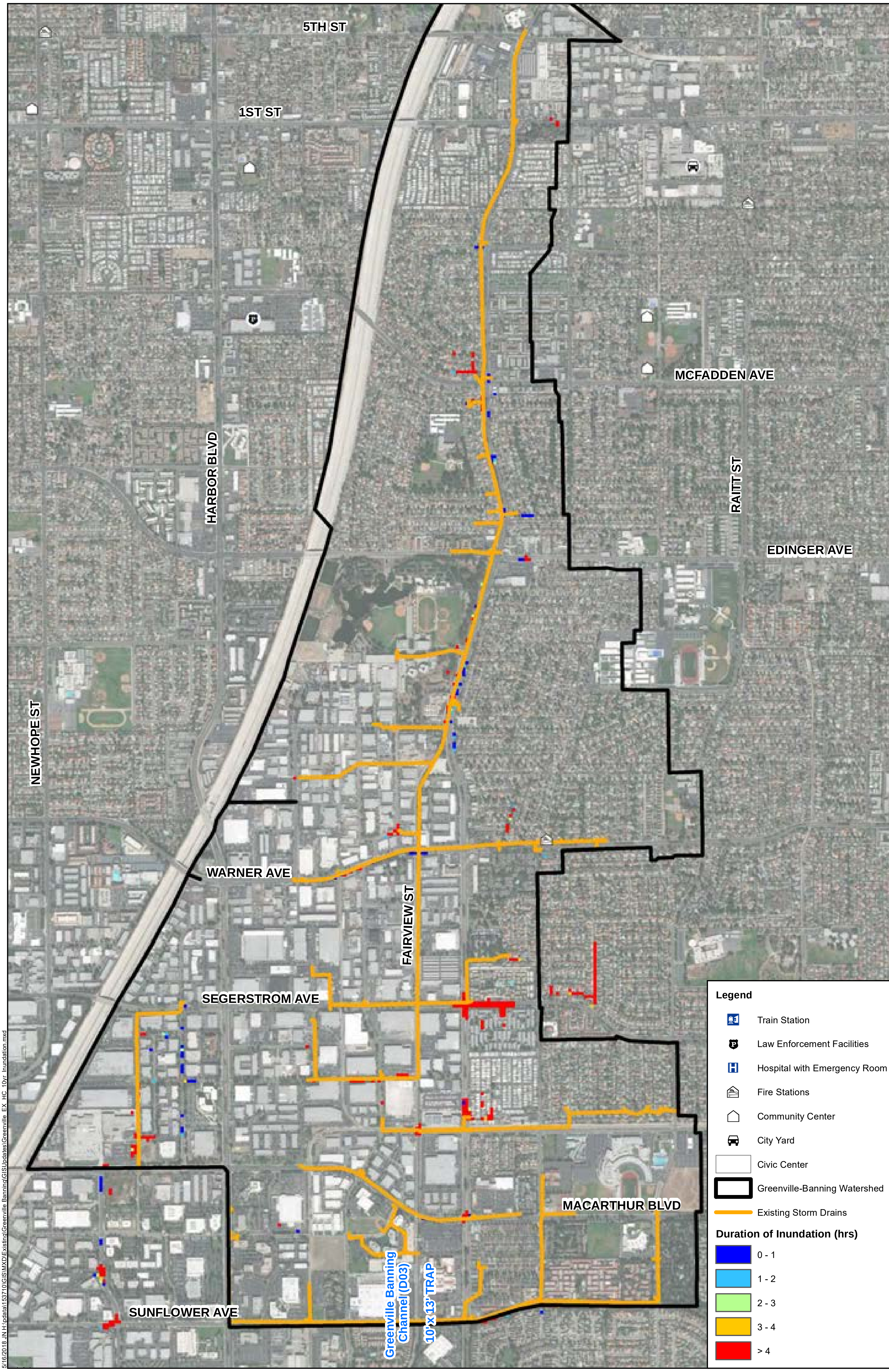
Feet

SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed - Maximum Flooded Depth Map

100-year Existing Condition

Figure 6-3



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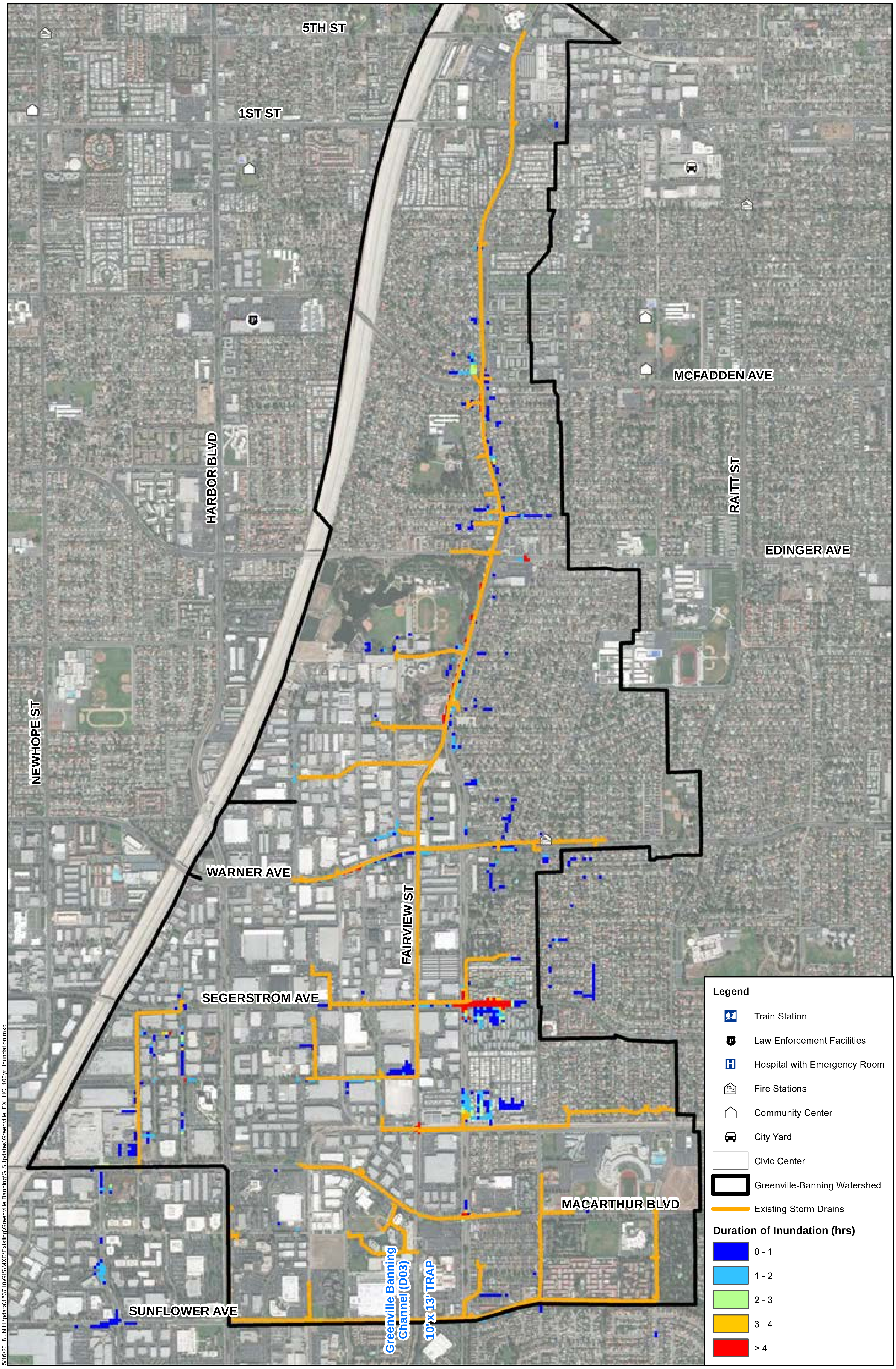
Feet

SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed - Duration of Inundation Map

10- year Existing Condition

Figure 6-4



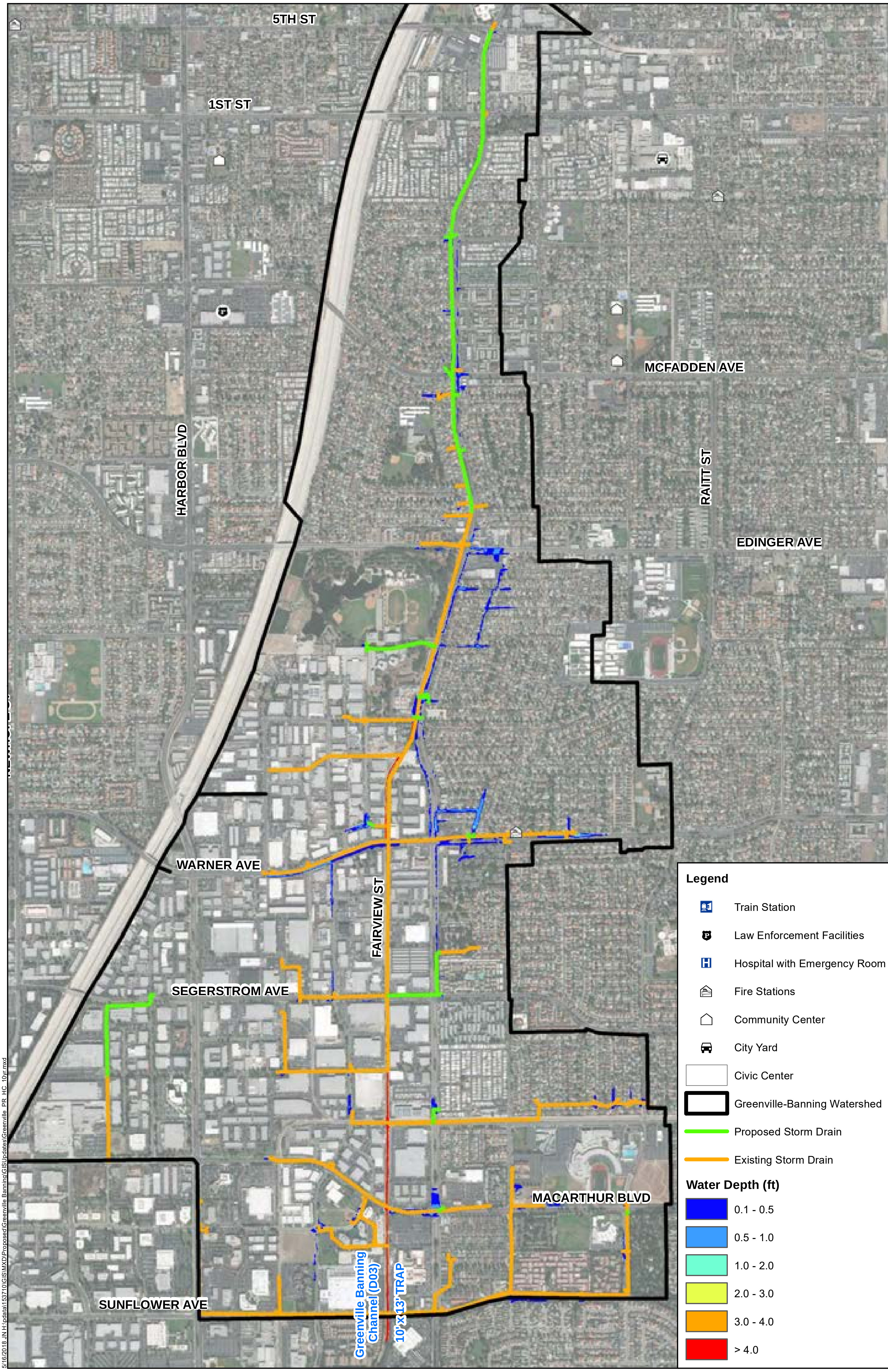
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed -Duration of Inundation Map

100-year Existing Condition

Figure 6-5



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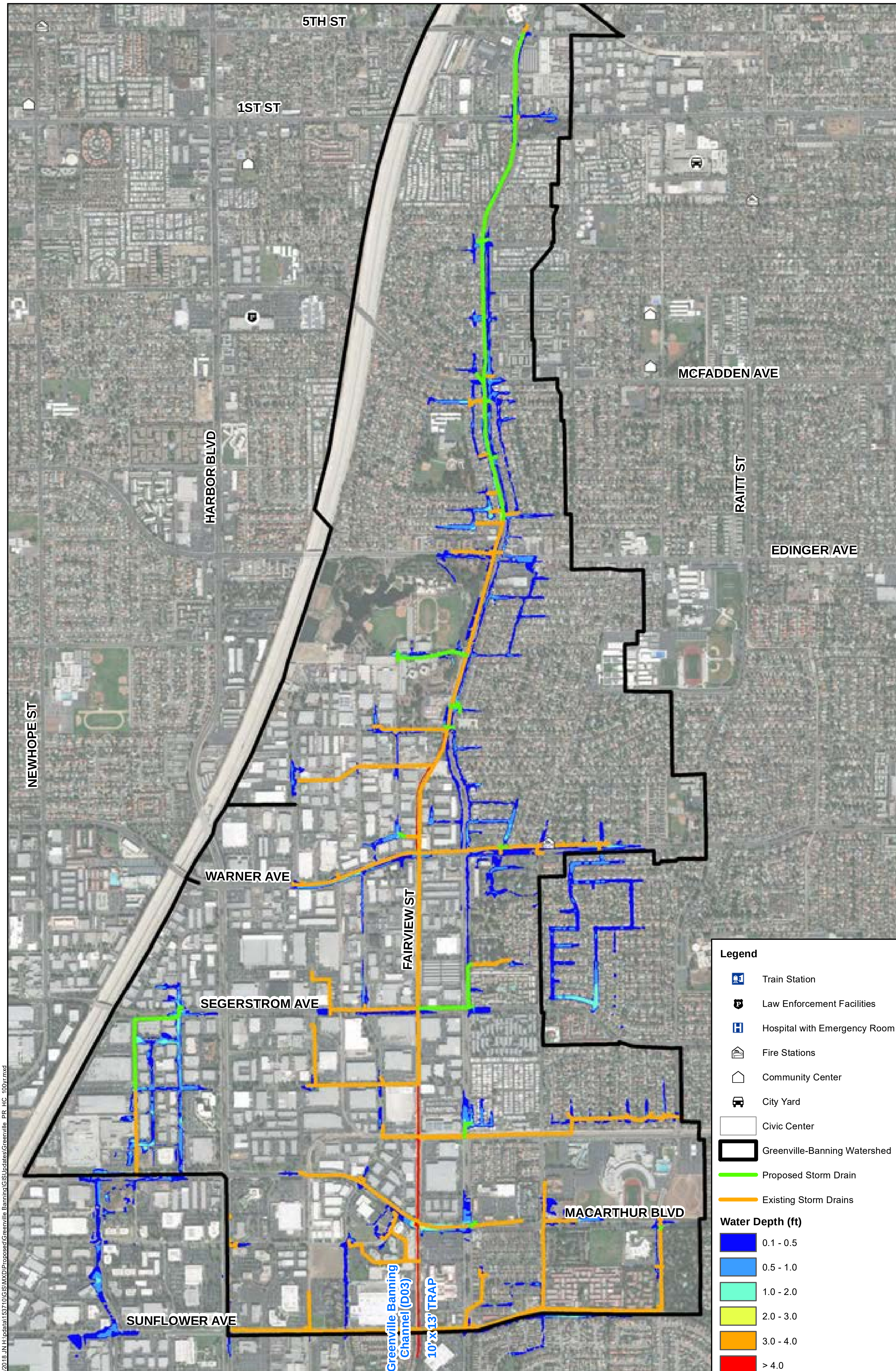
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed - Maximum Flooded Depth Map

10-year Proposed Condition

Figure 6-6



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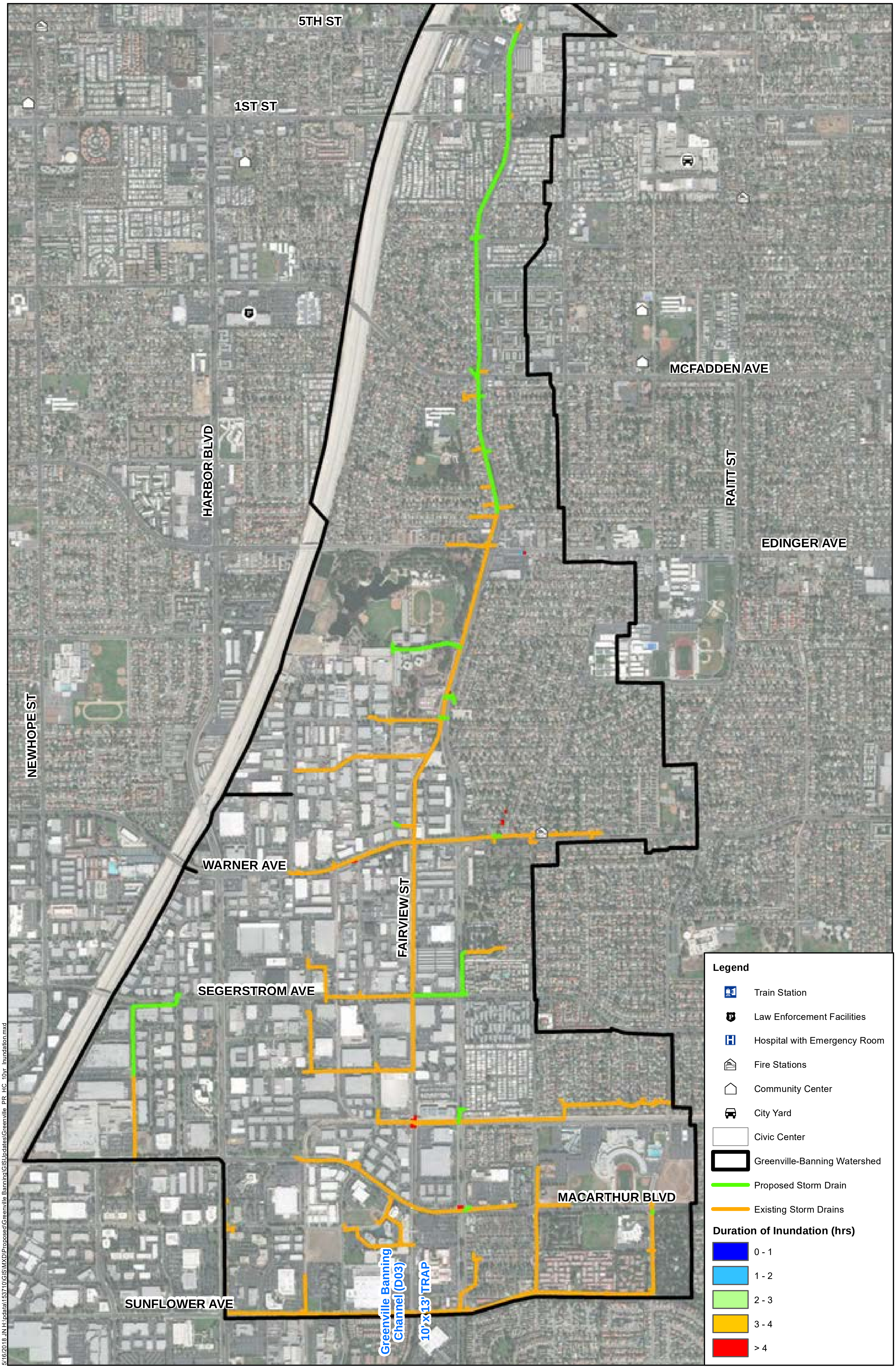
0 500 1,000
Feet

SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed - Maximum Flooded Depth Map
100-year Proposed Condition

Figure 6-7



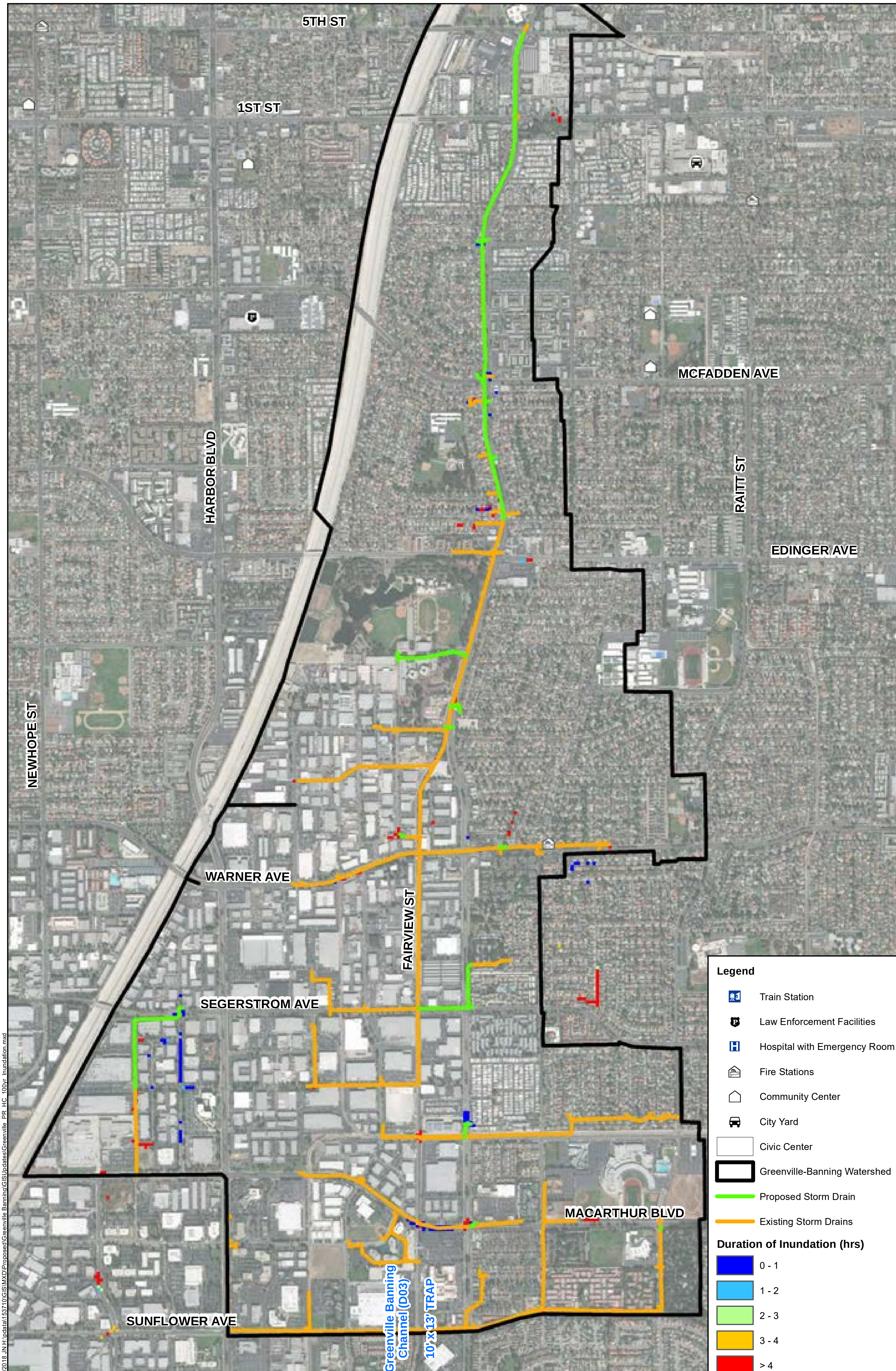
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed - Duration of Inundation Map

10- year Proposed Condition

Figure 6-8

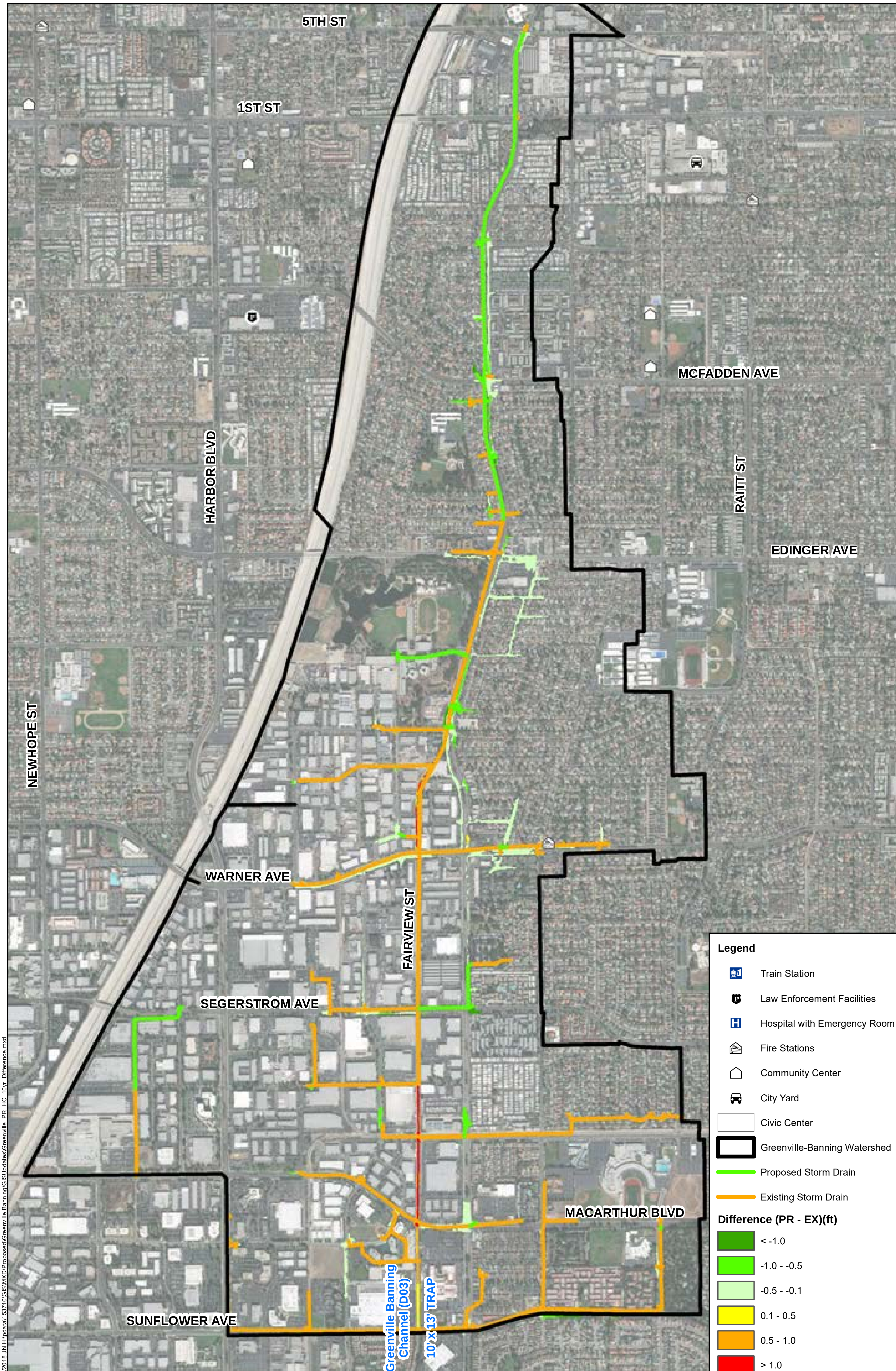


SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed -Duration of Inundation Map

100-year Proposed Condition

Figure 6-9



Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

Source:

SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed - 10- year Difference Map

Figure 6-10

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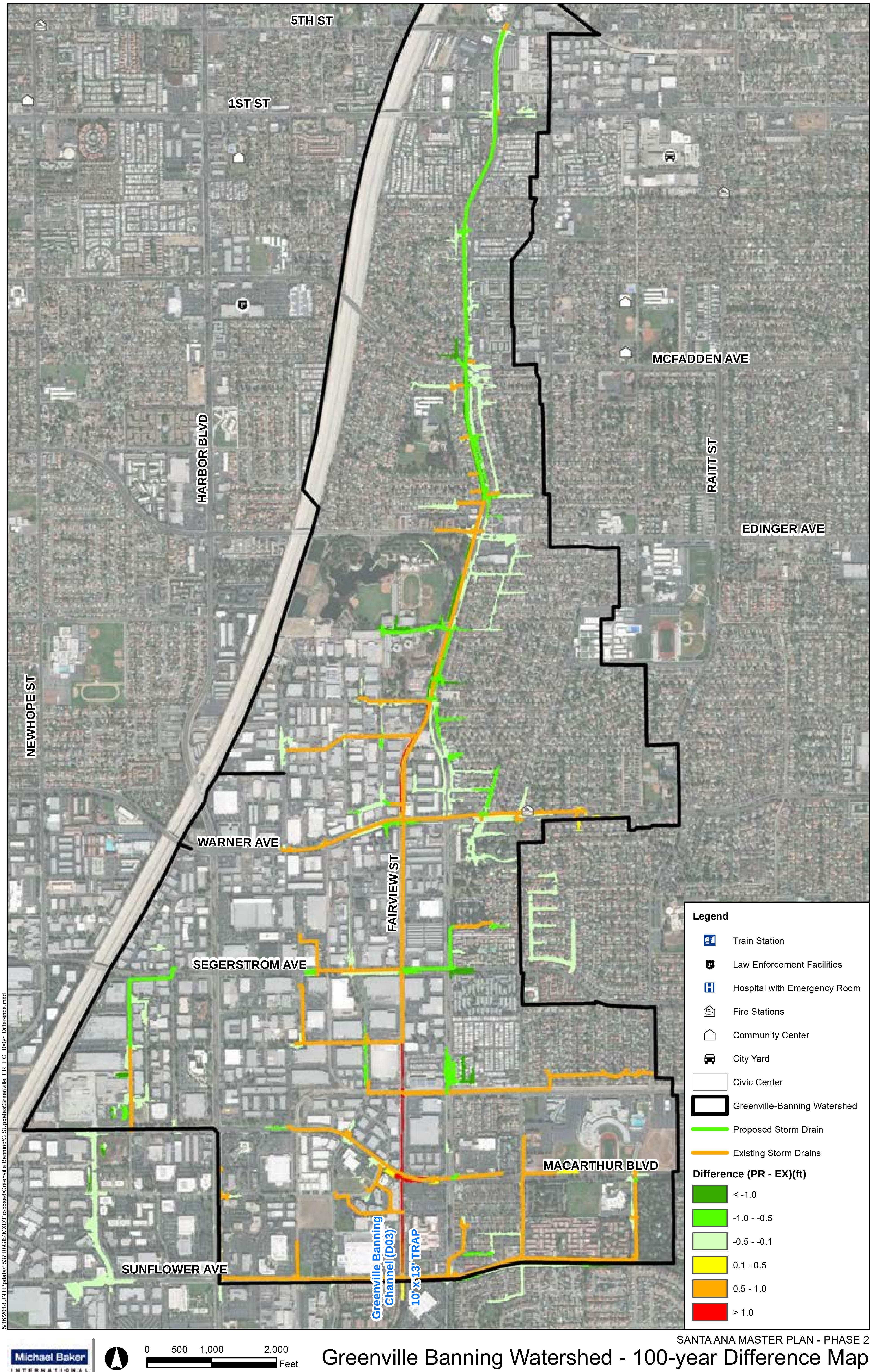
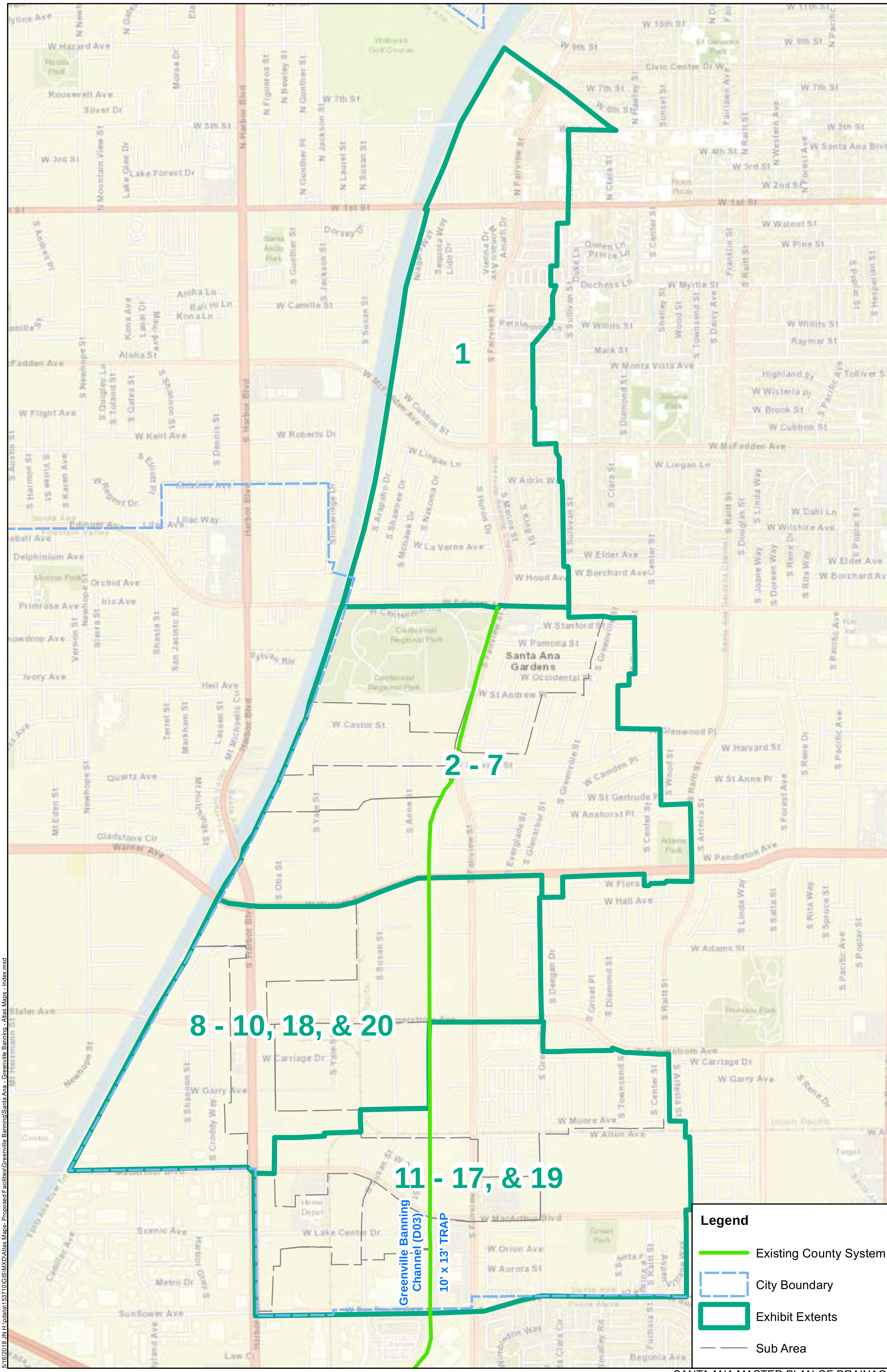


SANTA ANA MASTER PLAN - PHASE 2

Greenville Banning Watershed - 100-year Difference Map

Figure 6-11



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Michael Baker INTERNATIONAL

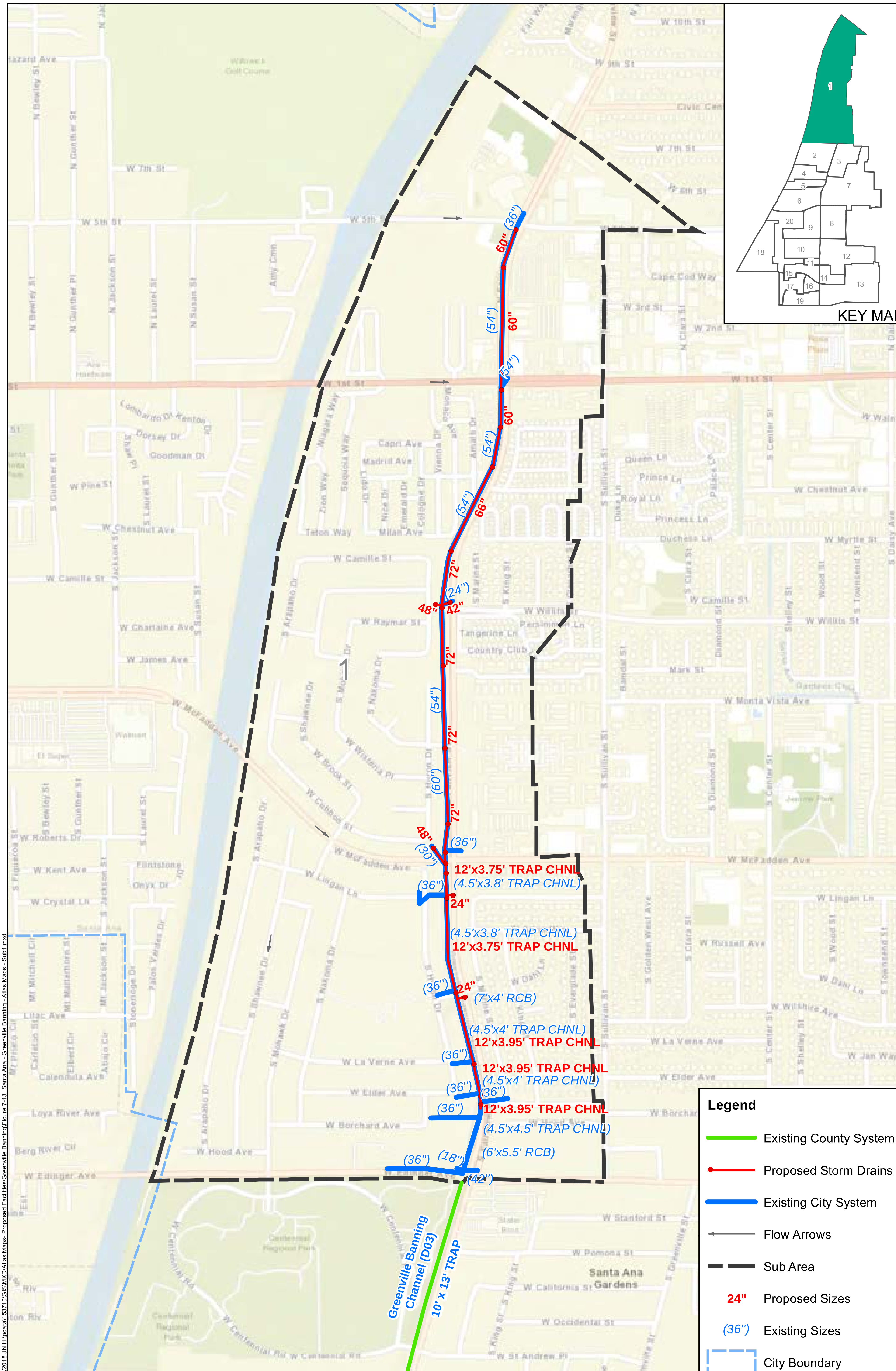
Source:

0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
GREENVILLE BANNING WATERSHED

Proposed Facilities - Exhibit Extents Index Map

Figure 6-12



5/16/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps- Proposed Facilities\Greenville Banning\Figure 7-13 Santa Ana - Greenville Banning - Atlas Maps - Sub1.mxd

Michael Baker INTERNATIONAL

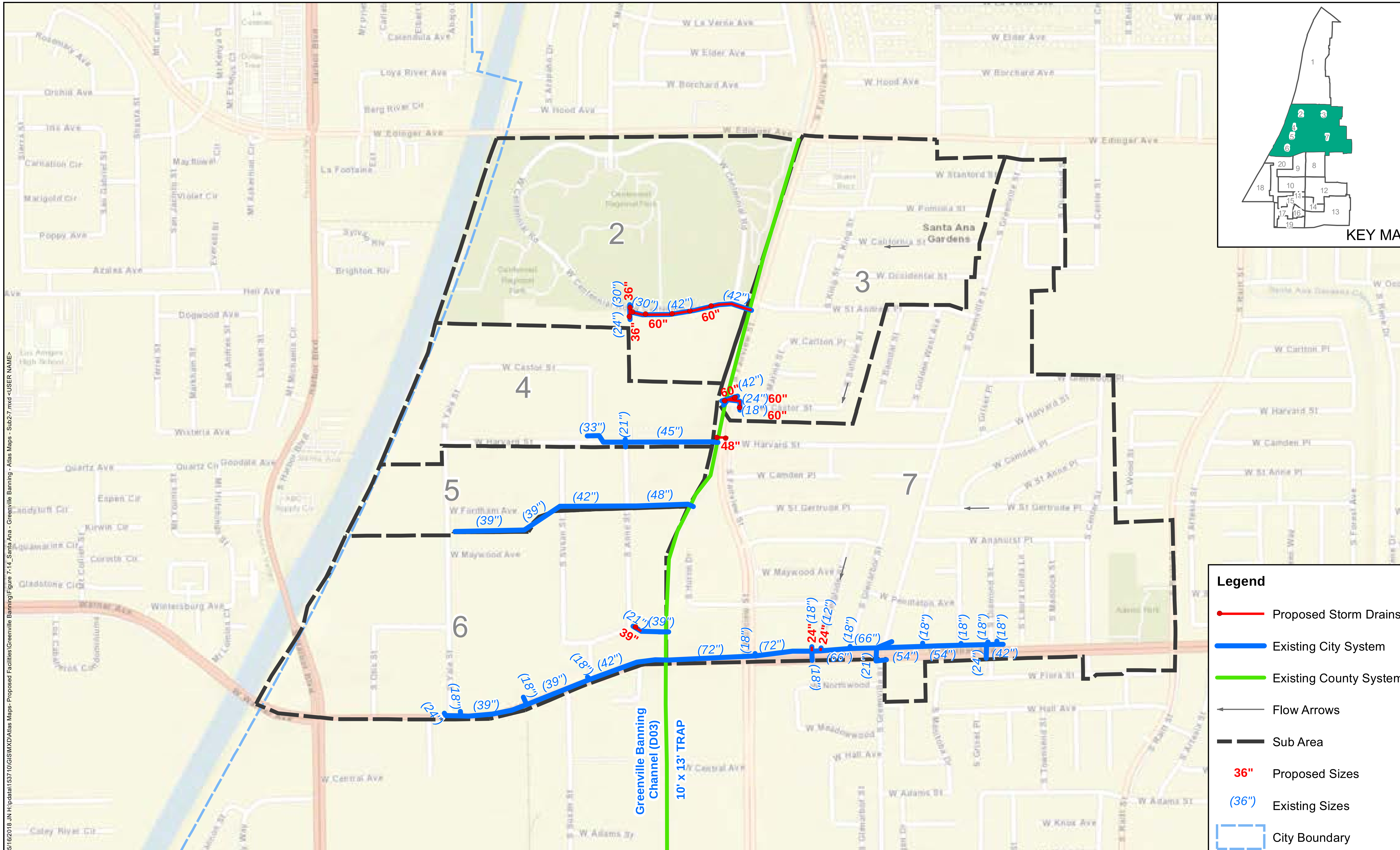
Source:

0 125 250 500 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
GREENVILLE BANNING WATERSHED

Proposed Facilities - Sub Area 1

Figure 6-13



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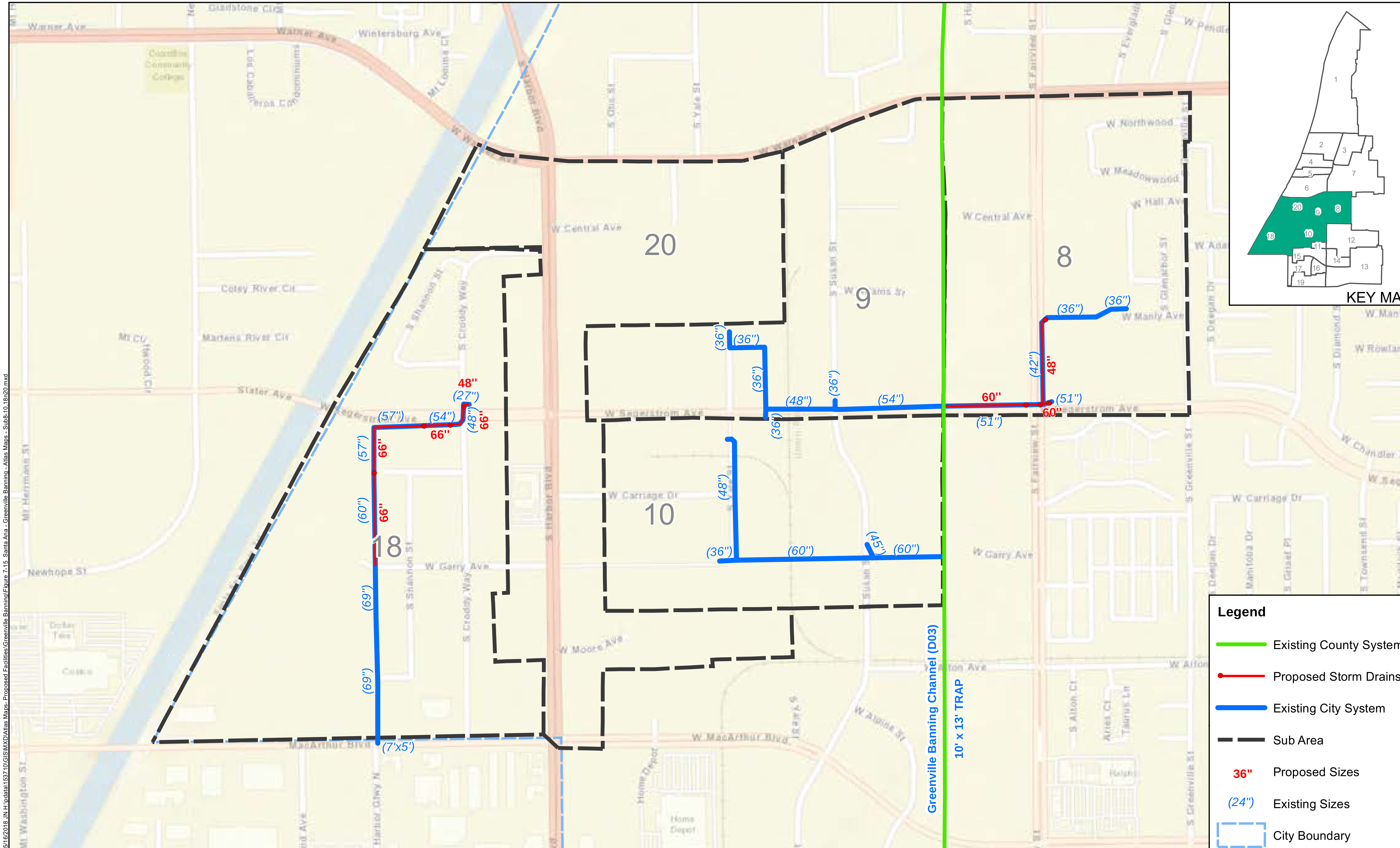
Michael Baker INTERNATIONAL

0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
GREENVILLE BANNING WATERSHED

Proposed Facilities - Sub Areas 2 - 7

Figure 6-14



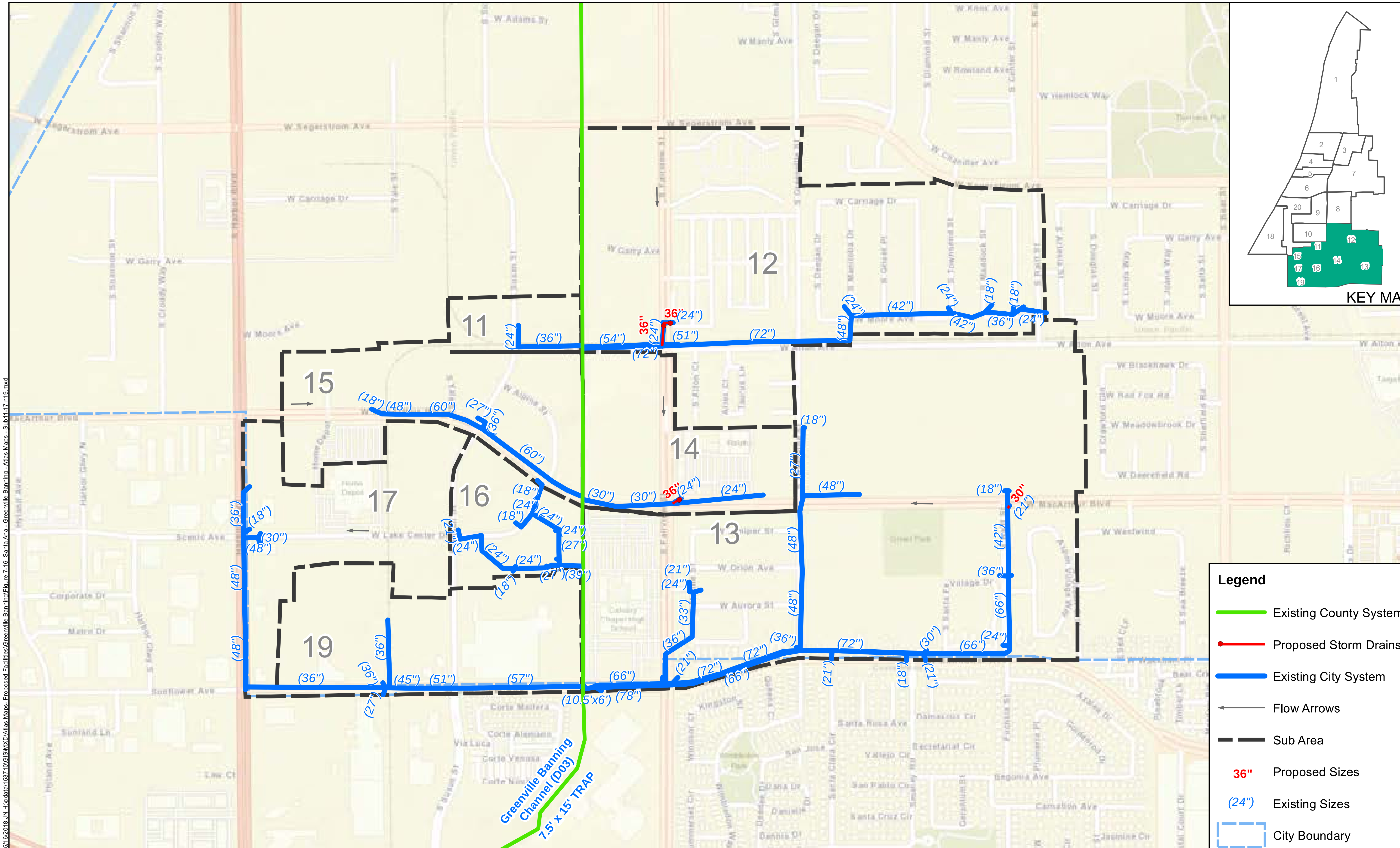
0 500 1,000 Feet

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
GREENVILLE BANNING WATERSHED

Proposed Facilities - Sub Areas 8 - 10, 18 & 20

Figure 6-15



0 500 1,000 Feet

Source:

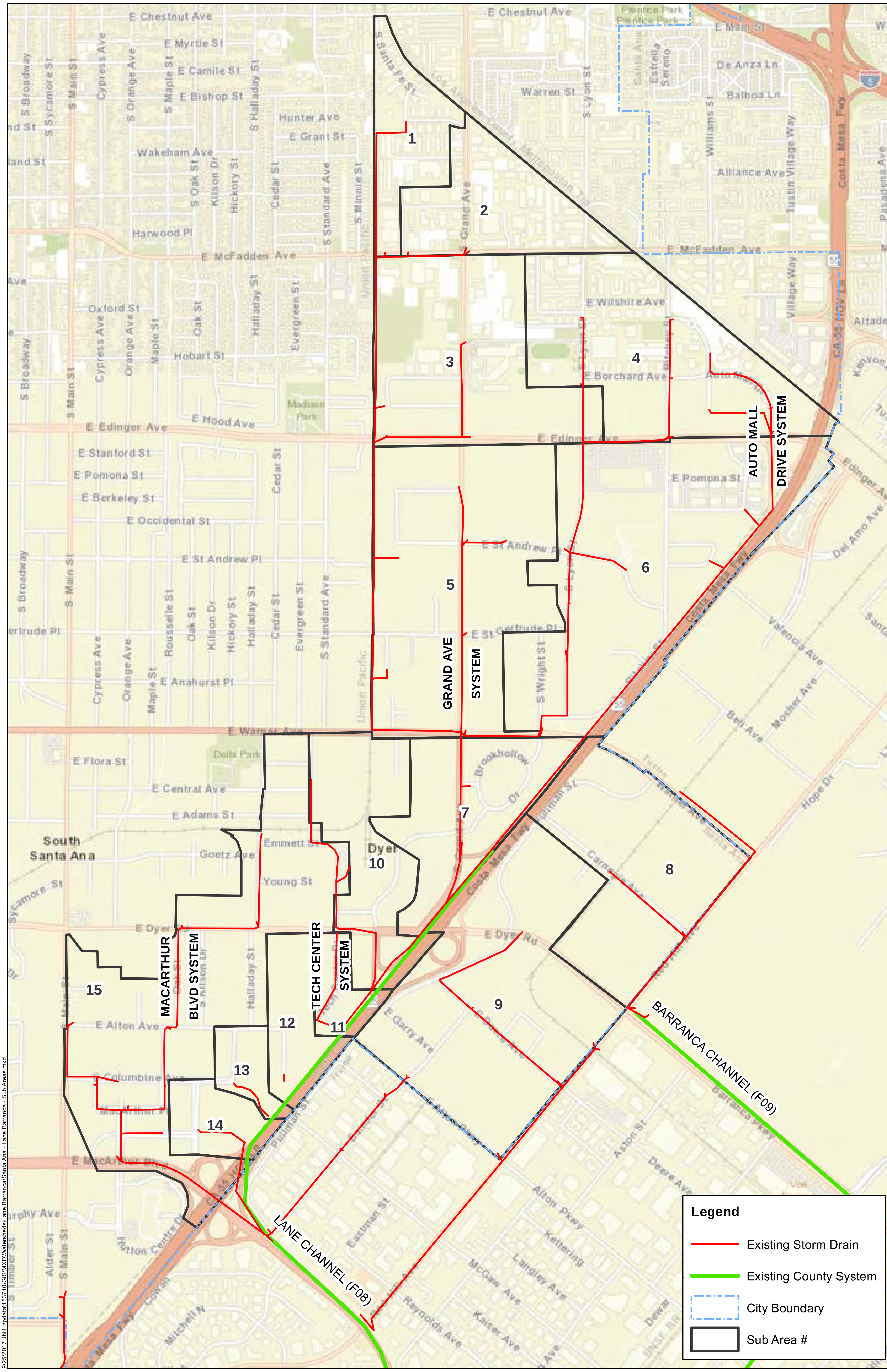
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN OF DRAINAGE
GREENVILLE BANNING WATERSHED

Proposed Facilities - Sub Areas 11 - 17 & 19

Figure 7-16

LANE BARRANCA EXHIBITS



SANTA ANA MASTER PLAN - PHASE 2

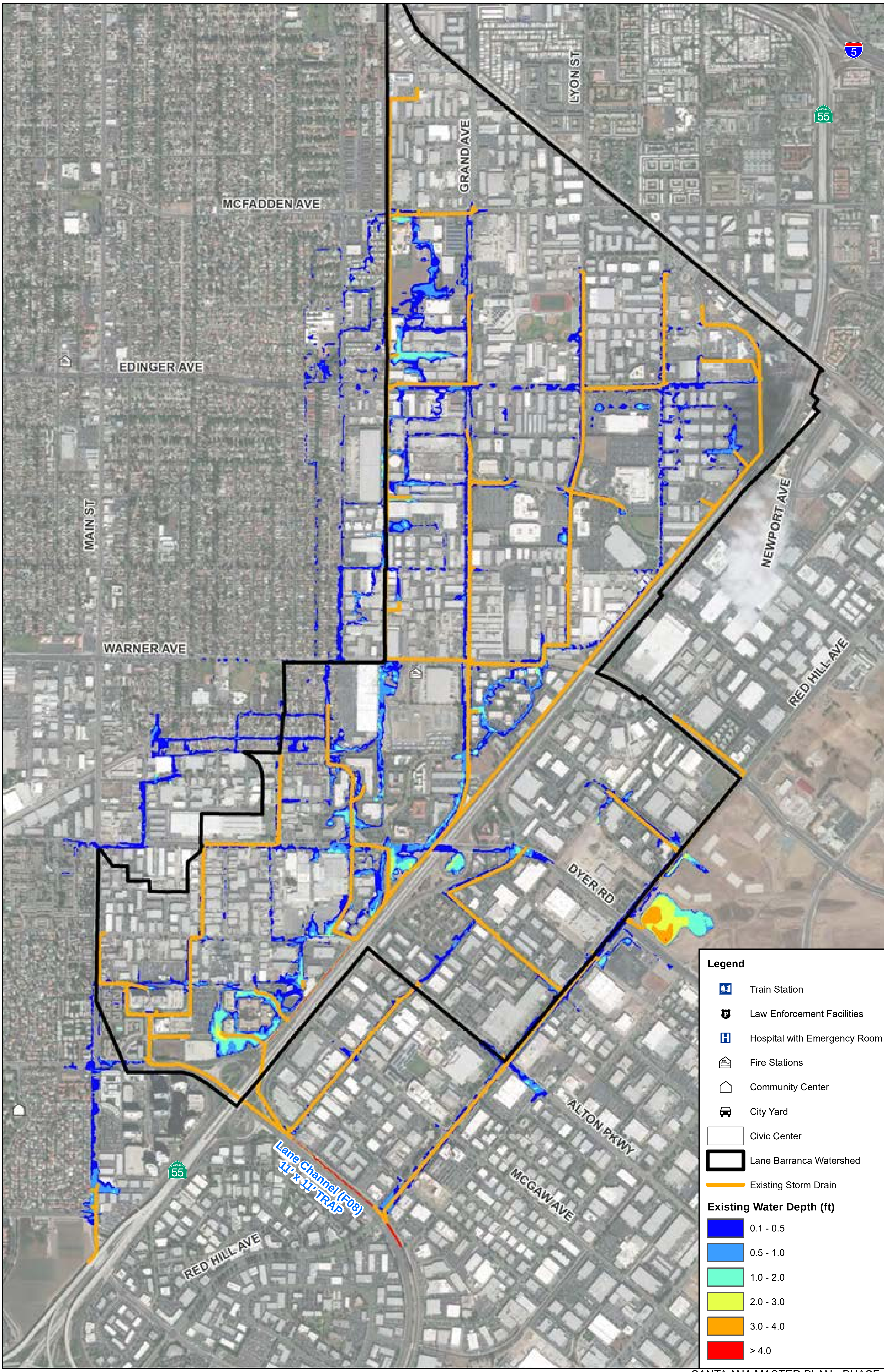
Lane-Barranca Watershed Sub Areas Exhibit

Figure 7-1

0 500 1,000 2,000 Feet

Source:

Michael Baker INTERNATIONAL



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Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

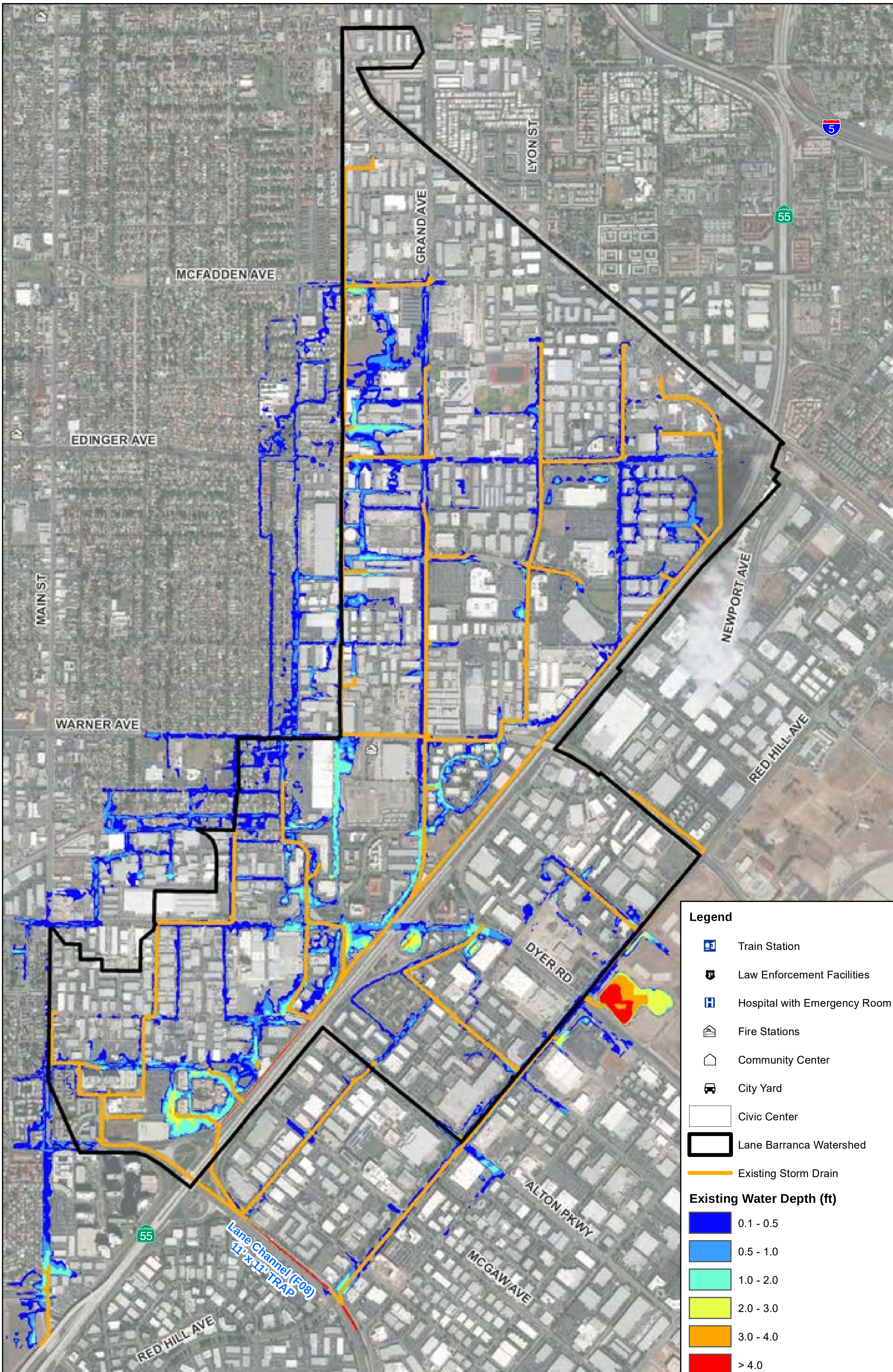
Source:

SANTA ANA MASTER PLAN - PHASE 2

Lane Barranca Watershed - Maximum Flooded Depth Map

10- year Existing Condition

Figure 7-2



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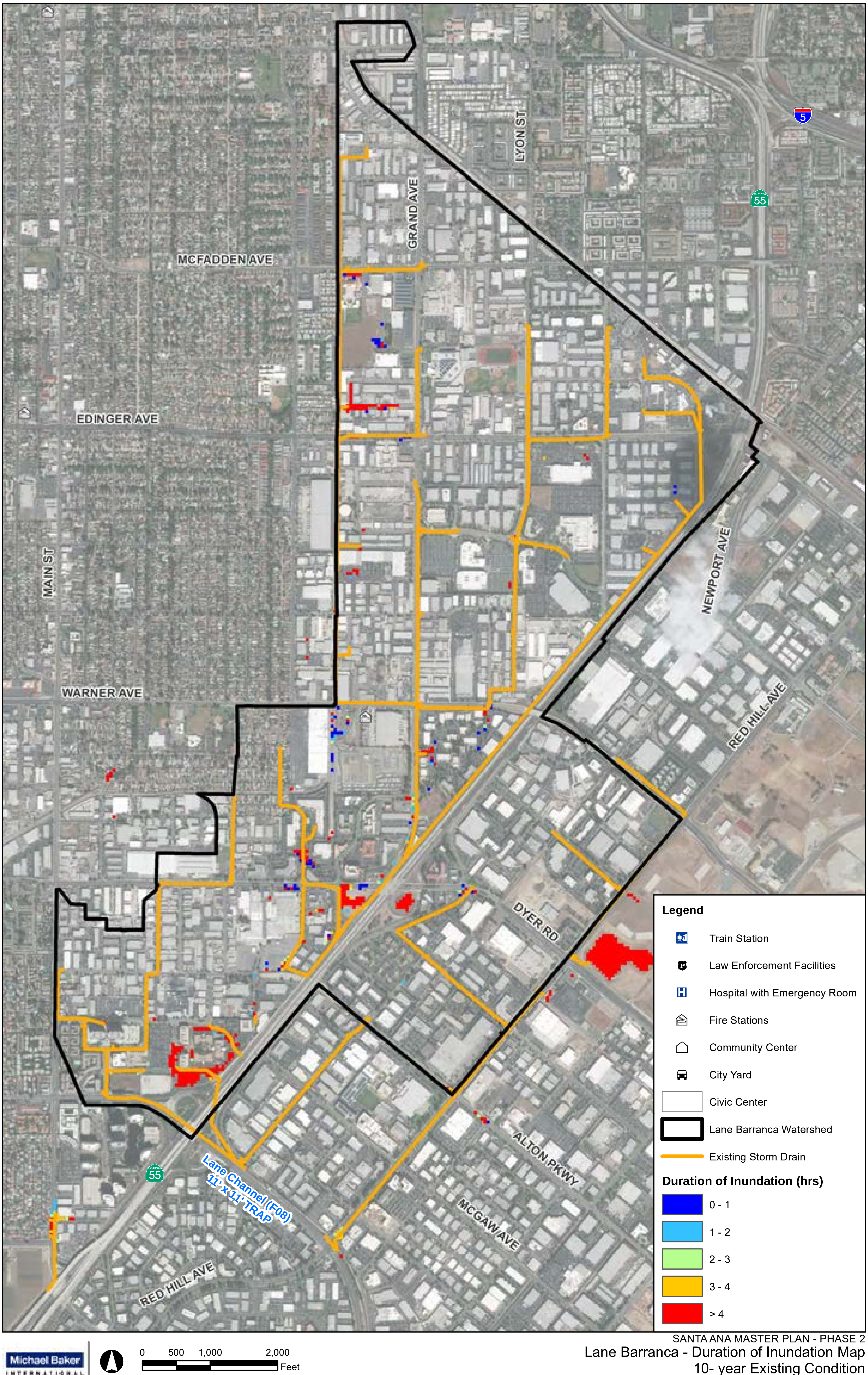
Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Lane Barranca Watershed - Maximum Flooded Depth Map
100- year Existing Condition

Figure 7-3



5/17/2018 JN H:\pdata\153710\GIS\MXD\Existing\GISUpdates\Lane_EX_HC_10yr_Inundation.mxd <USER NAME>

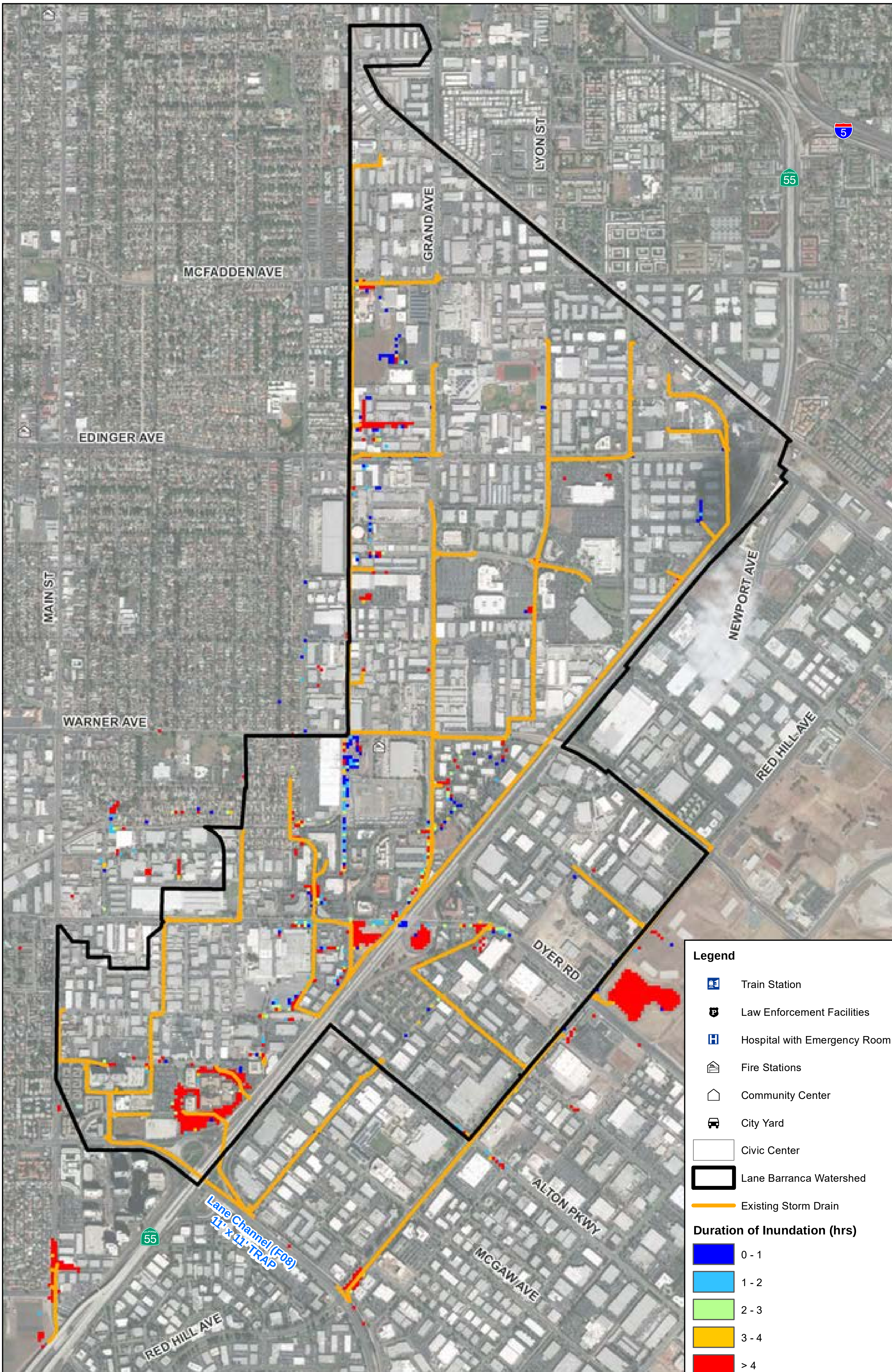
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Lane Barranca - Duration of Inundation Map

10- year Existing Condition

Figure 7-4



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0 500 1,000 2,000 Feet

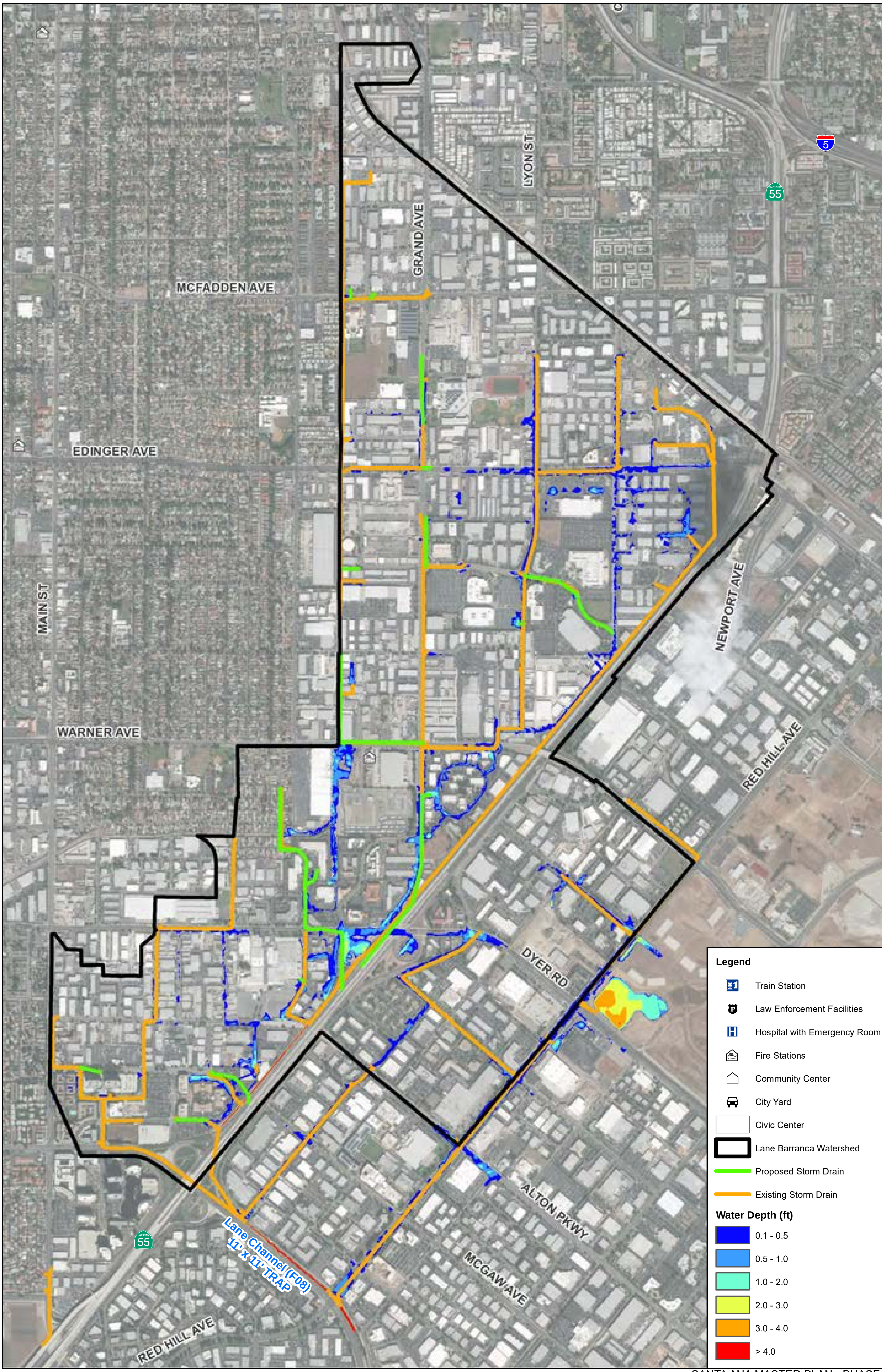
Source:

SANTA ANA MASTER PLAN - PHASE 2

Lane Barranca - Duration of Inundation Map

100- year Existing Condition

Figure 7-5



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Michael Baker INTERNATIONAL

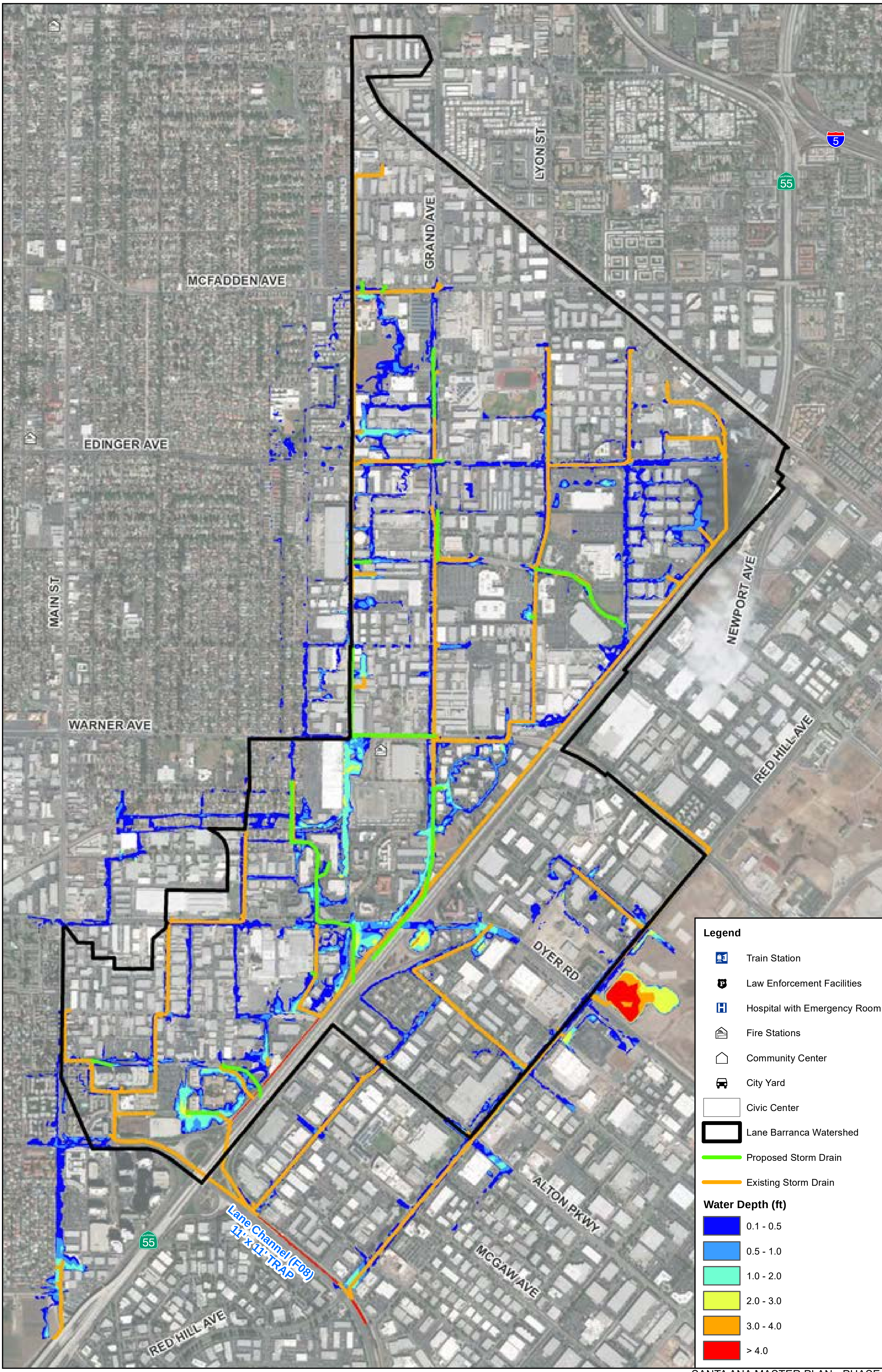
Source:

SANTA ANA MASTER PLAN - PHASE 2

Lane Barranca Watershed - Maximum Flooded Depth Map

10- year Proposed Condition

Figure 7-6



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Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

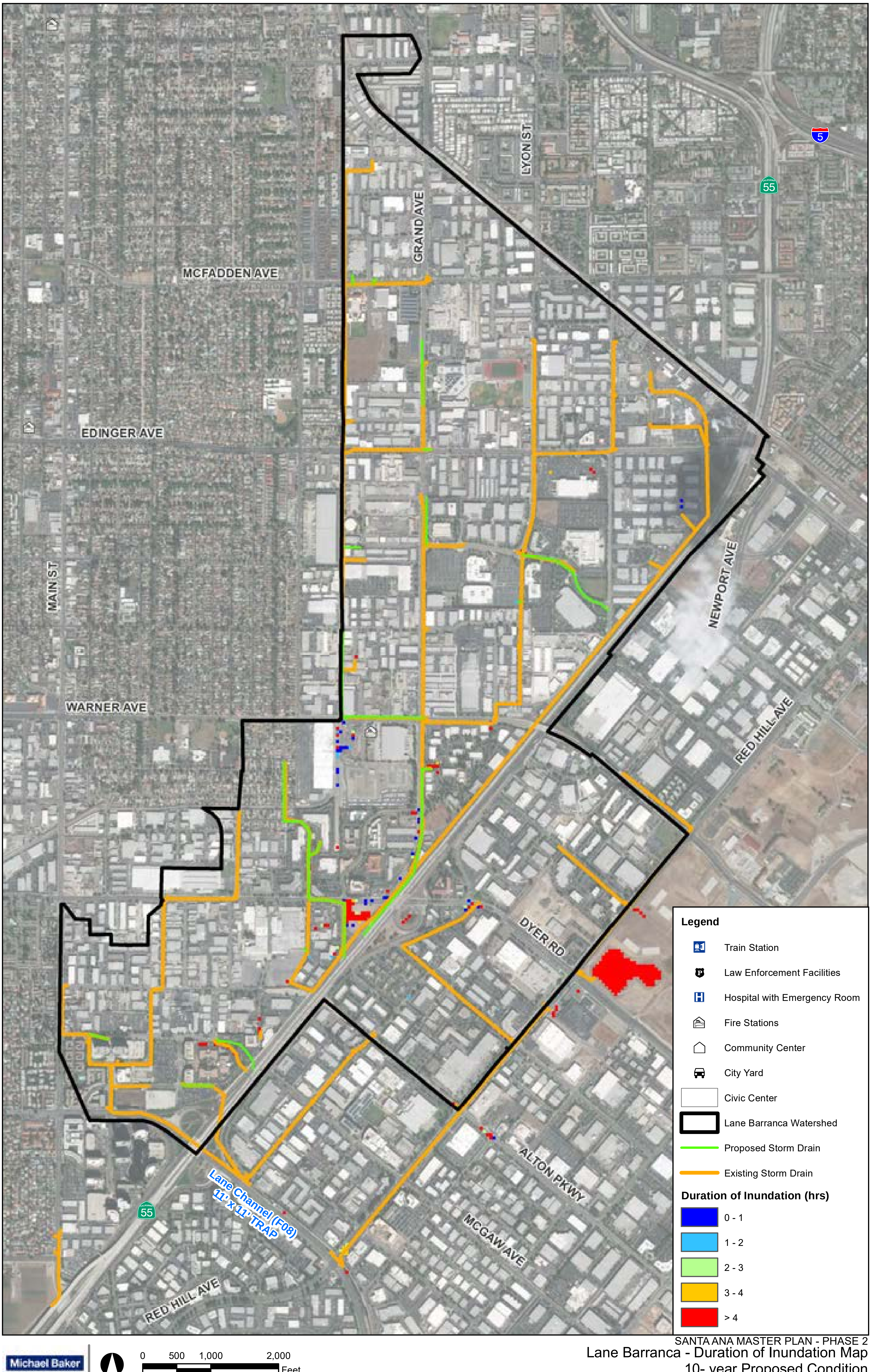
Source:

SANTA ANA MASTER PLAN - PHASE 2

Lane Barranca Watershed - Maximum Flooded Depth Map

100- year Proposed Condition

Figure 7-7



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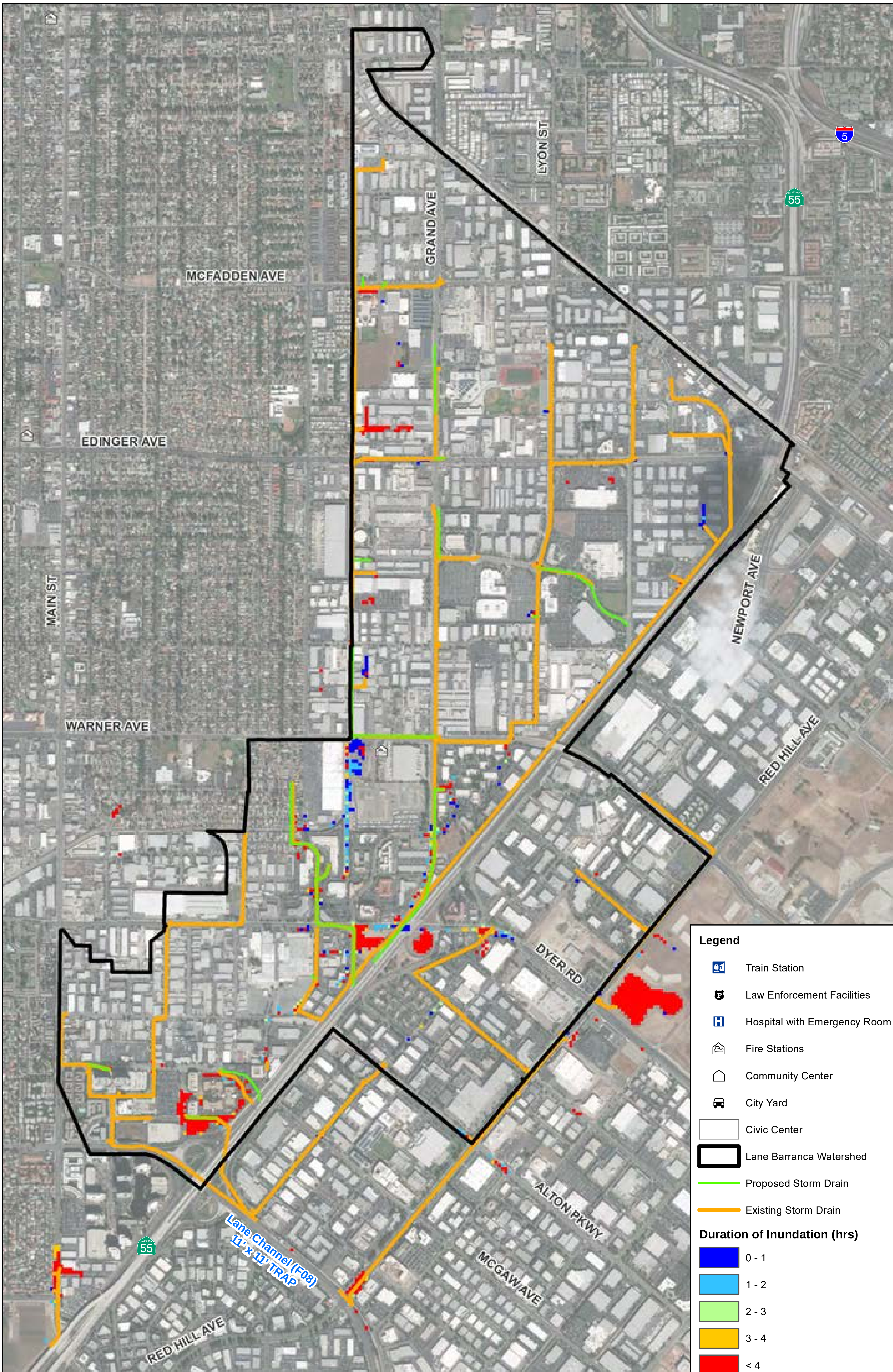
SANTA ANA MASTER PLAN - PHASE 2

Lane Barranca - Duration of Inundation Map

10- year Proposed Condition

Figure 7-8



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Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

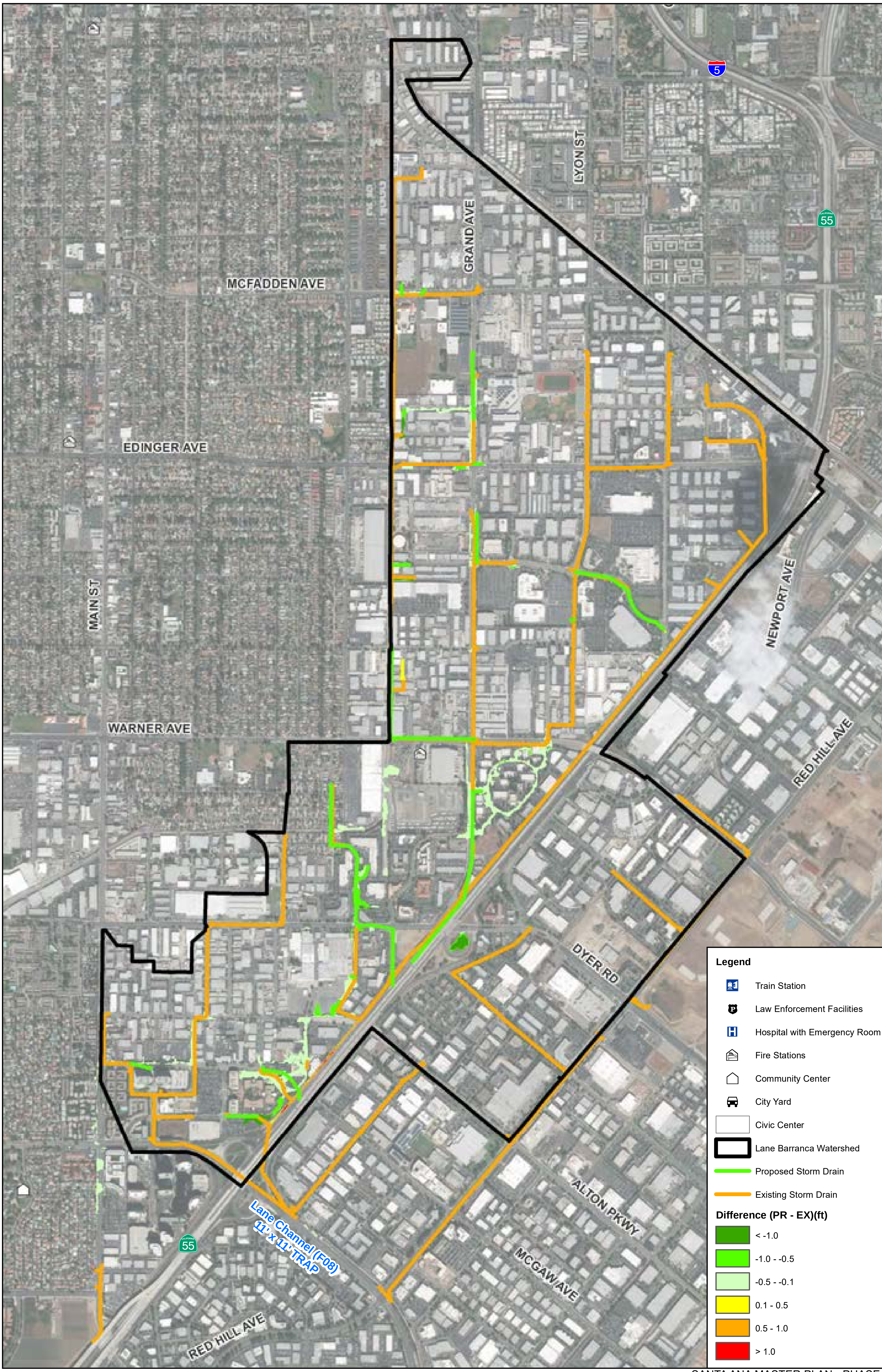
Source:

SANTA ANA MASTER PLAN - PHASE 2

Lane Barranca - Duration of Inundation Map

100- year Proposed Condition

Figure 7-9



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SANTA ANA MASTER PLAN - PHASE 2

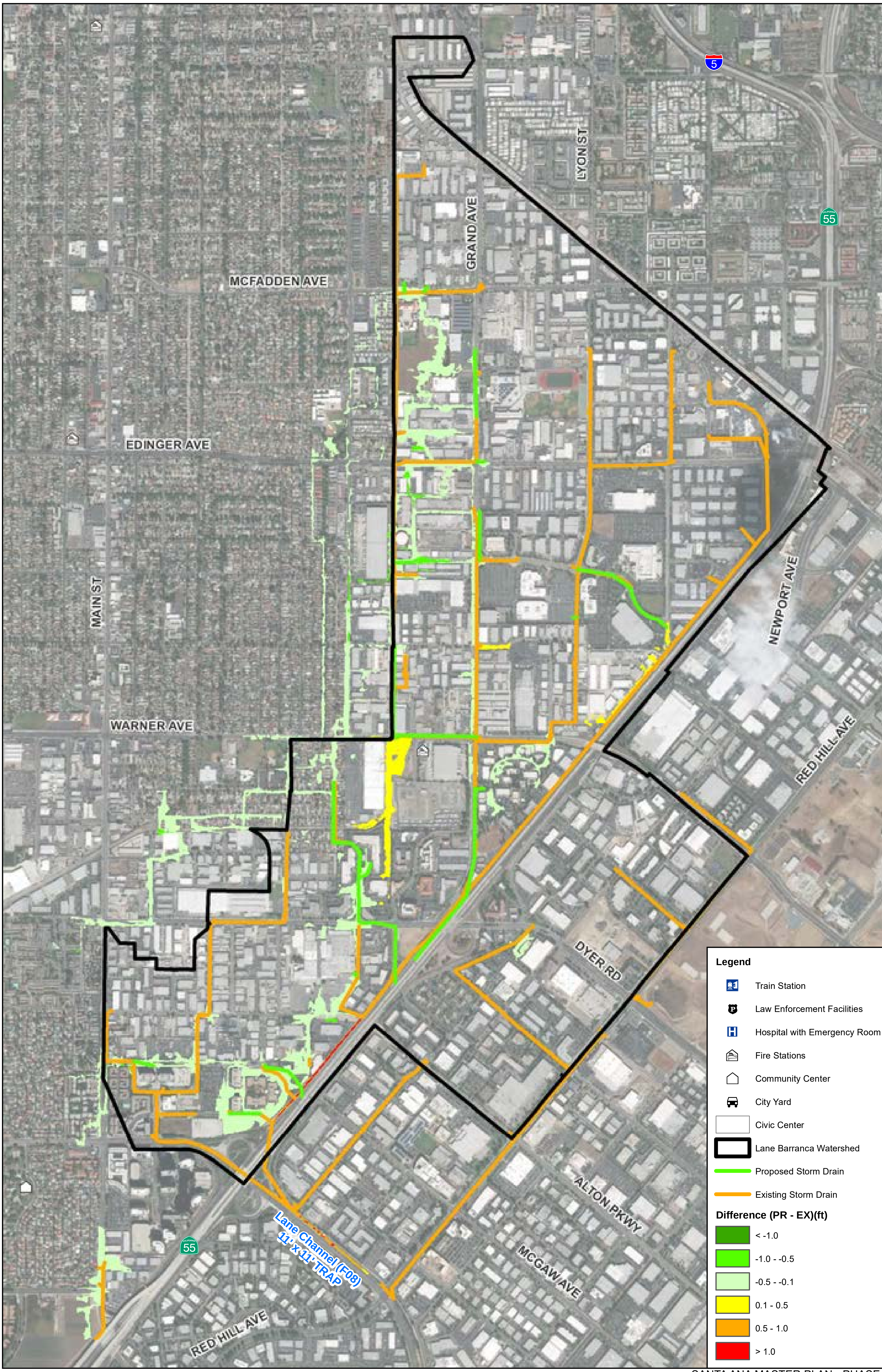
Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

Source:

Lane Barranca Watershed - 10- year Difference Map

Figure 7-10



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SANTA ANA MASTER PLAN - PHASE 2

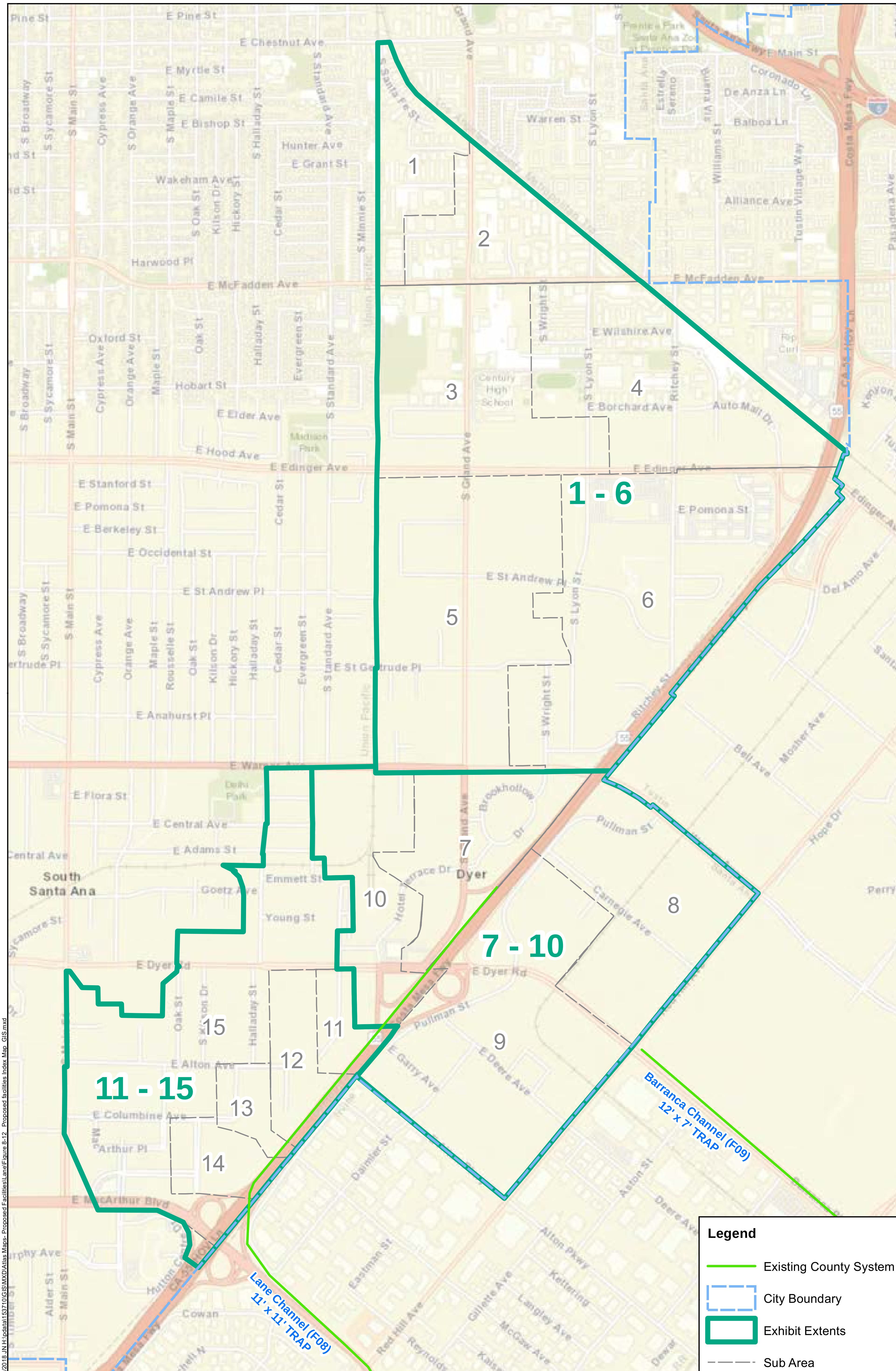
Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

Source:

Lane Barranca Watershed - 100- year Difference Map

Figure 7-11



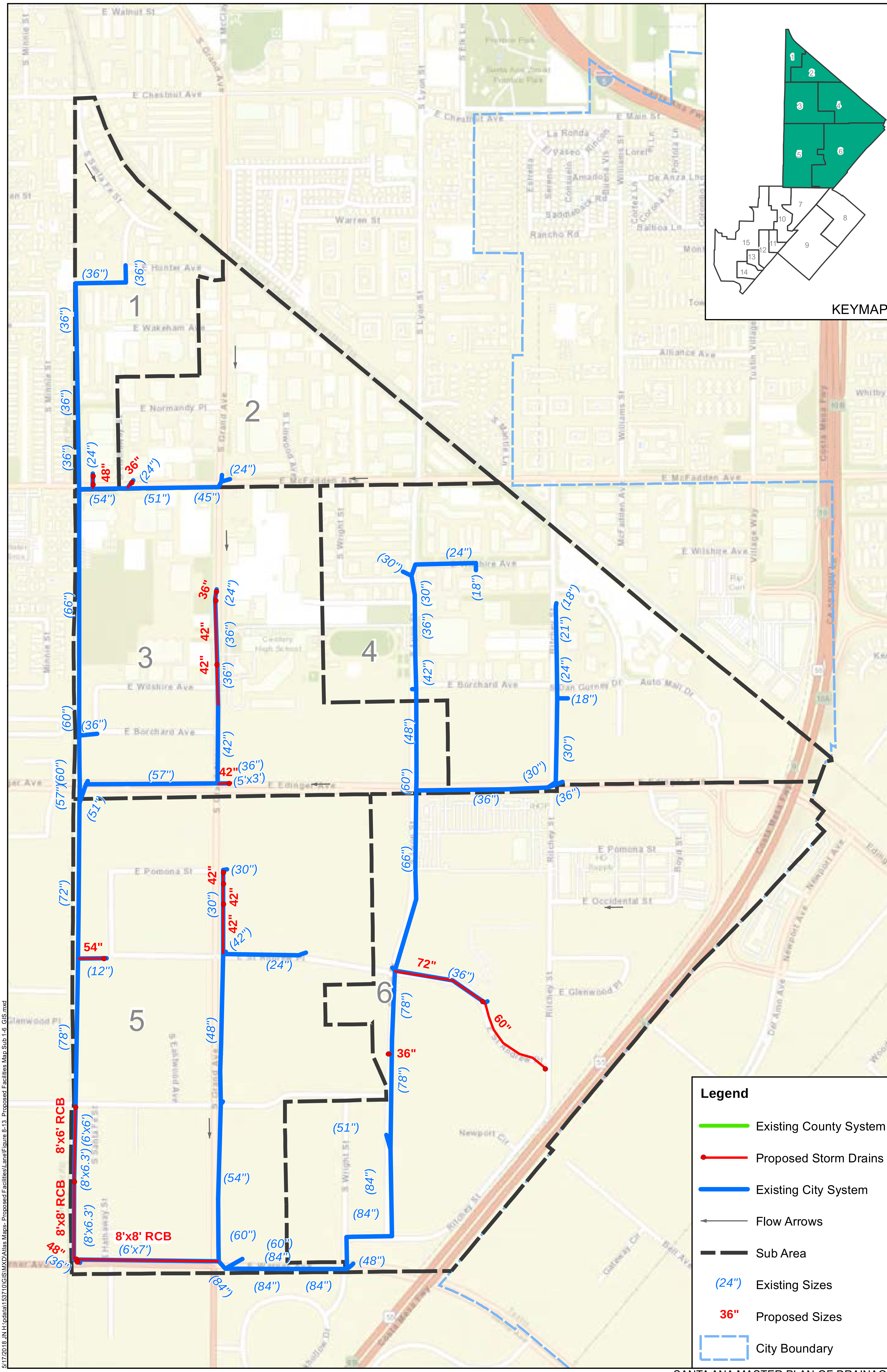
Michael Baker INTERNATIONAL

0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
LANE BARRANCA WATERSHED

Proposed Facilities - Exhibit Extents Index Map

Figure 7-12



Michael Baker INTERNATIONAL

0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
LANE BARRANCA WATERSHED

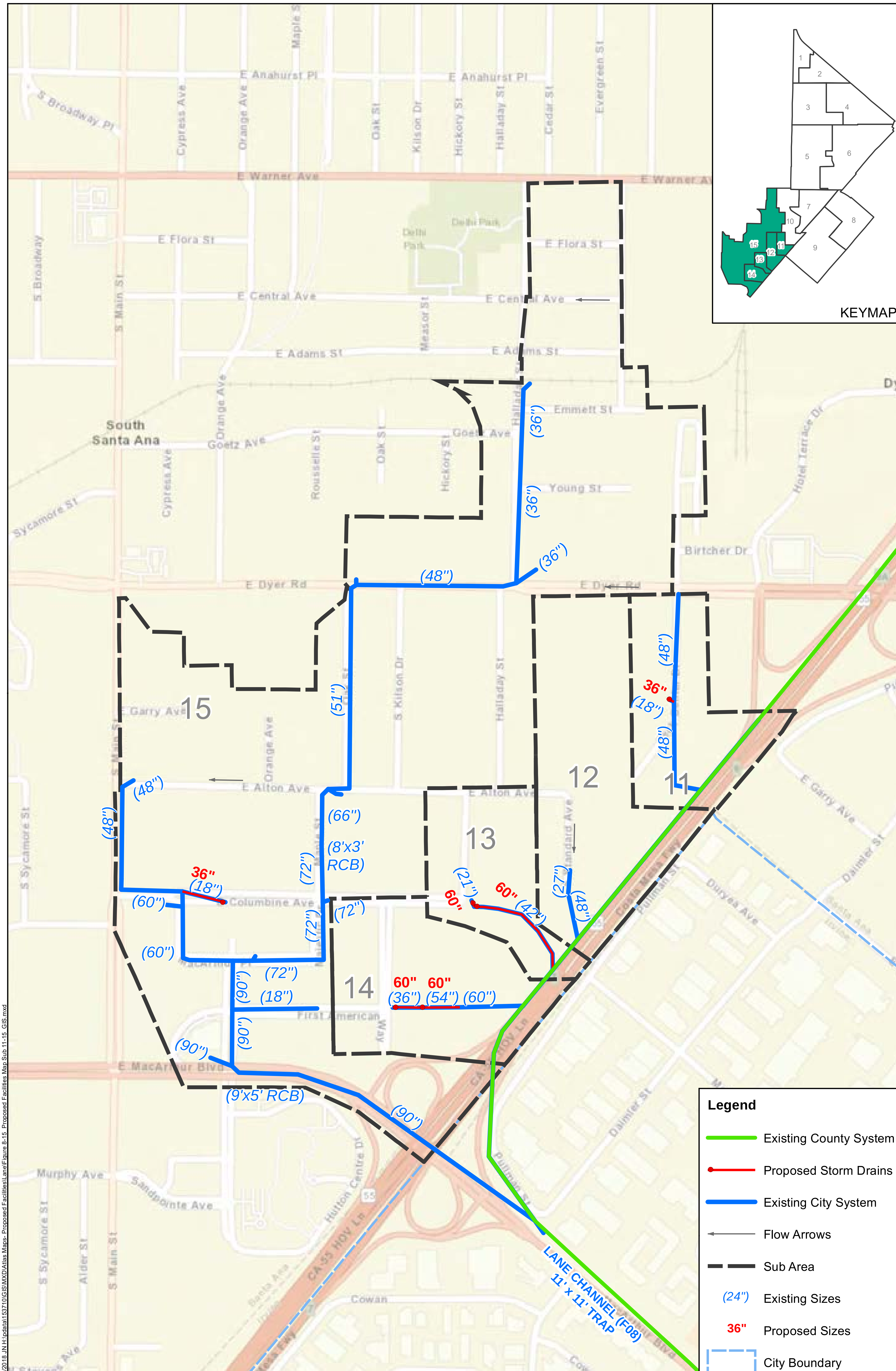
PROPOSED FACILITIES - SUB AREAS 1 - 6

FIGURE 7-13

SANTA ANA MASTER PLAN OF DRAINAGE
LANE BARRANCA WATERSHED

PROPOSED FACILITIES - SUB AREAS 7 - 10

FIGURE 7-14



5/17/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps- Proposed Facilities\Lane\Figure 8-15_Proposed Facilities Map Sub 11-15_GIS.mxd

Michael Baker INTERNATIONAL

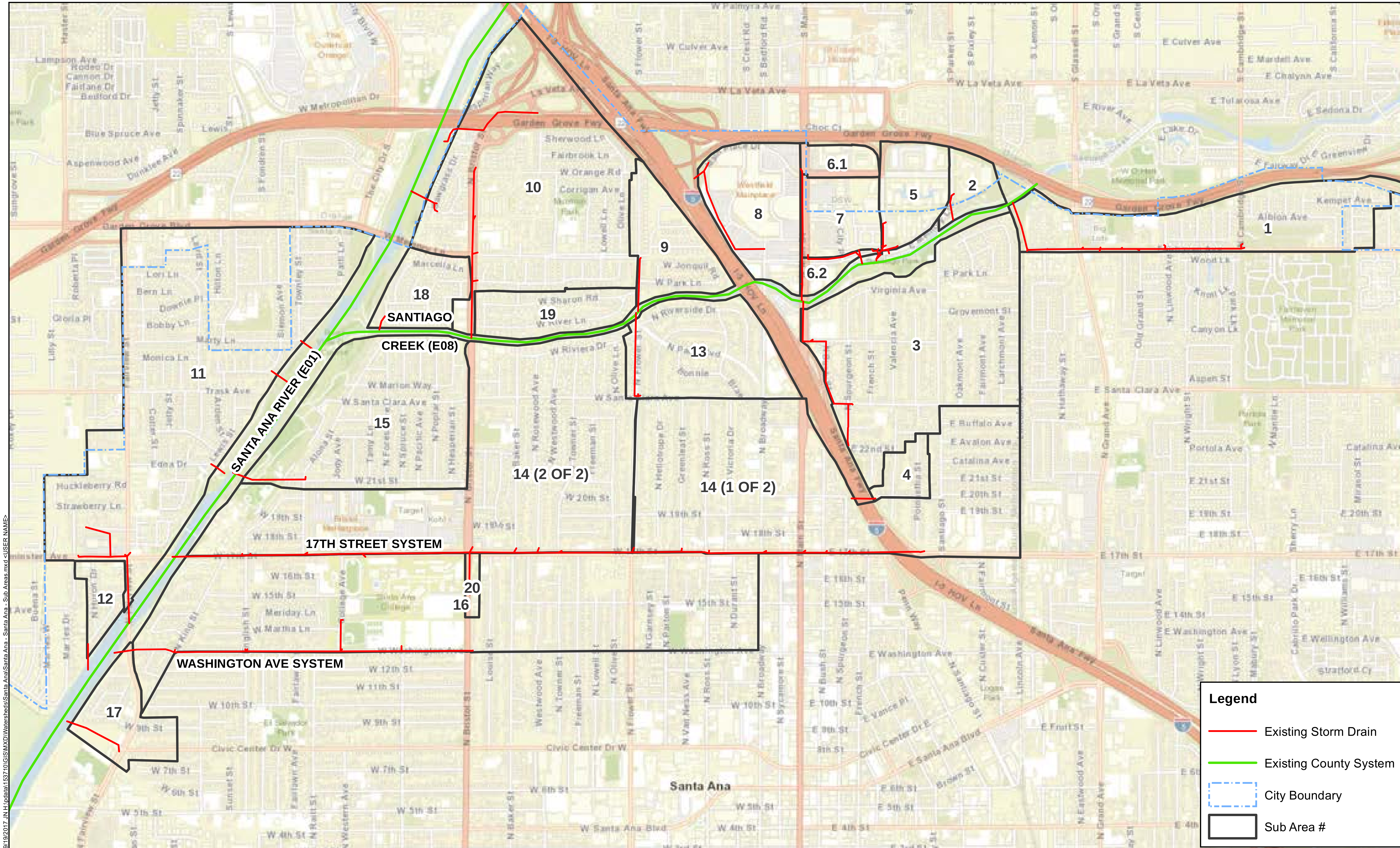
0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
LANE BARRANCA WATERSHED

PROPOSED FACILITIES - SUB AREAS 11 - 15

FIGURE 7-15

SANTA ANA EXHIBITS



Michael Baker INTERNATIONAL

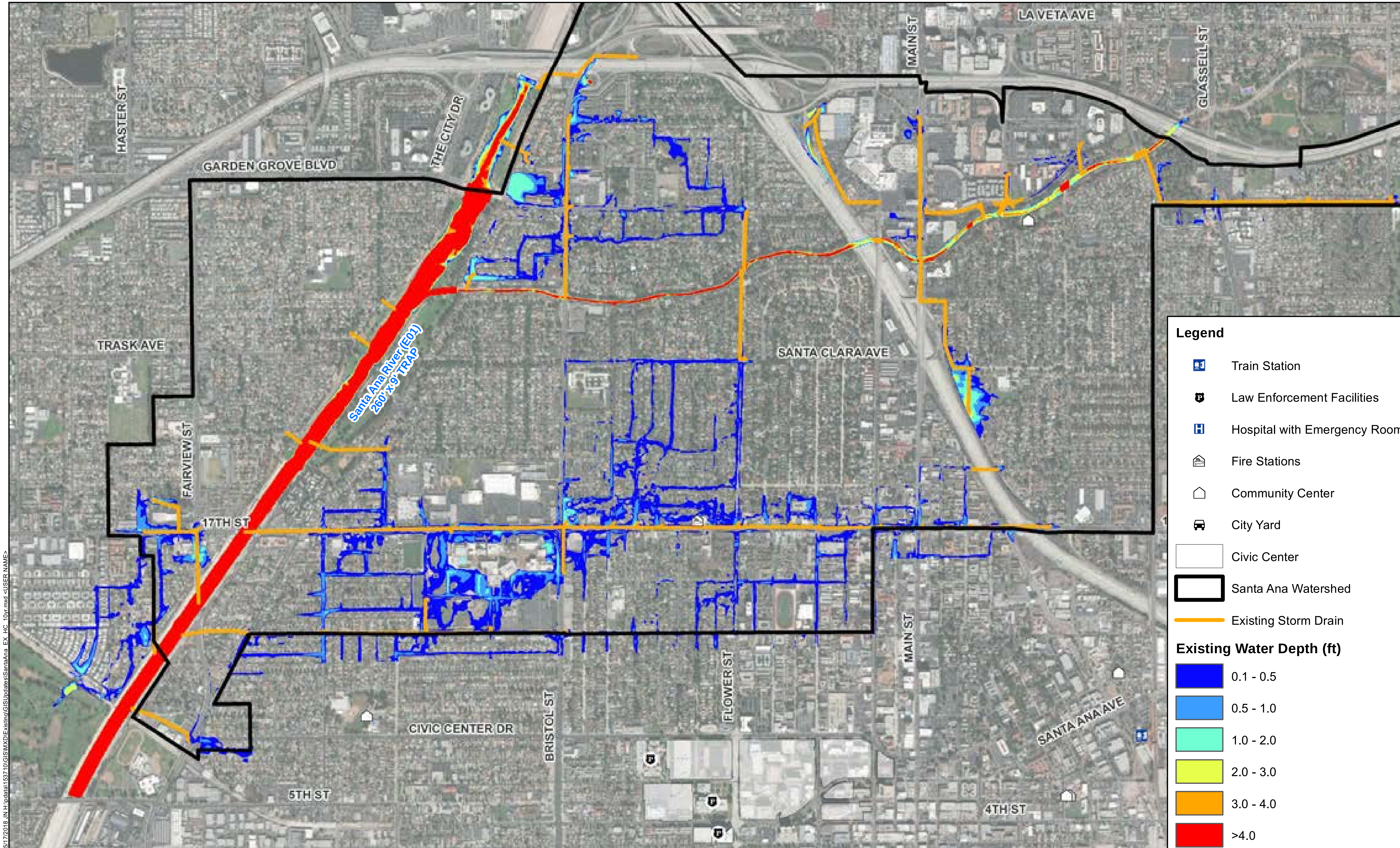
0 1,000 2,000 4,000 Feet

Source:

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed Sub Areas Exhibit

Figure 8-1



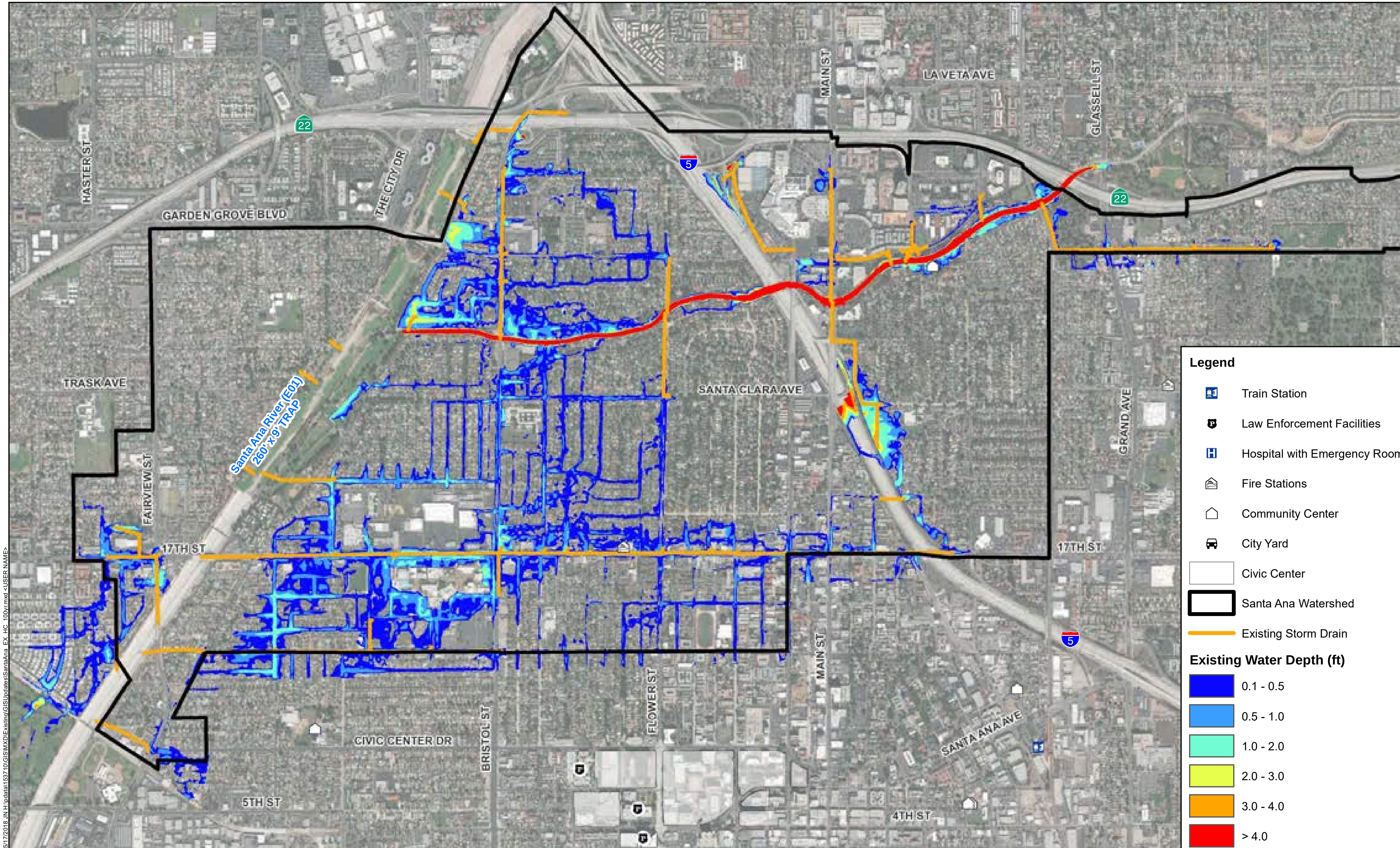
Michael Baker INTERNATIONAL

Source:

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - Maximum Flooded Depth Map
10- year Existing Condition

Figure 8-2



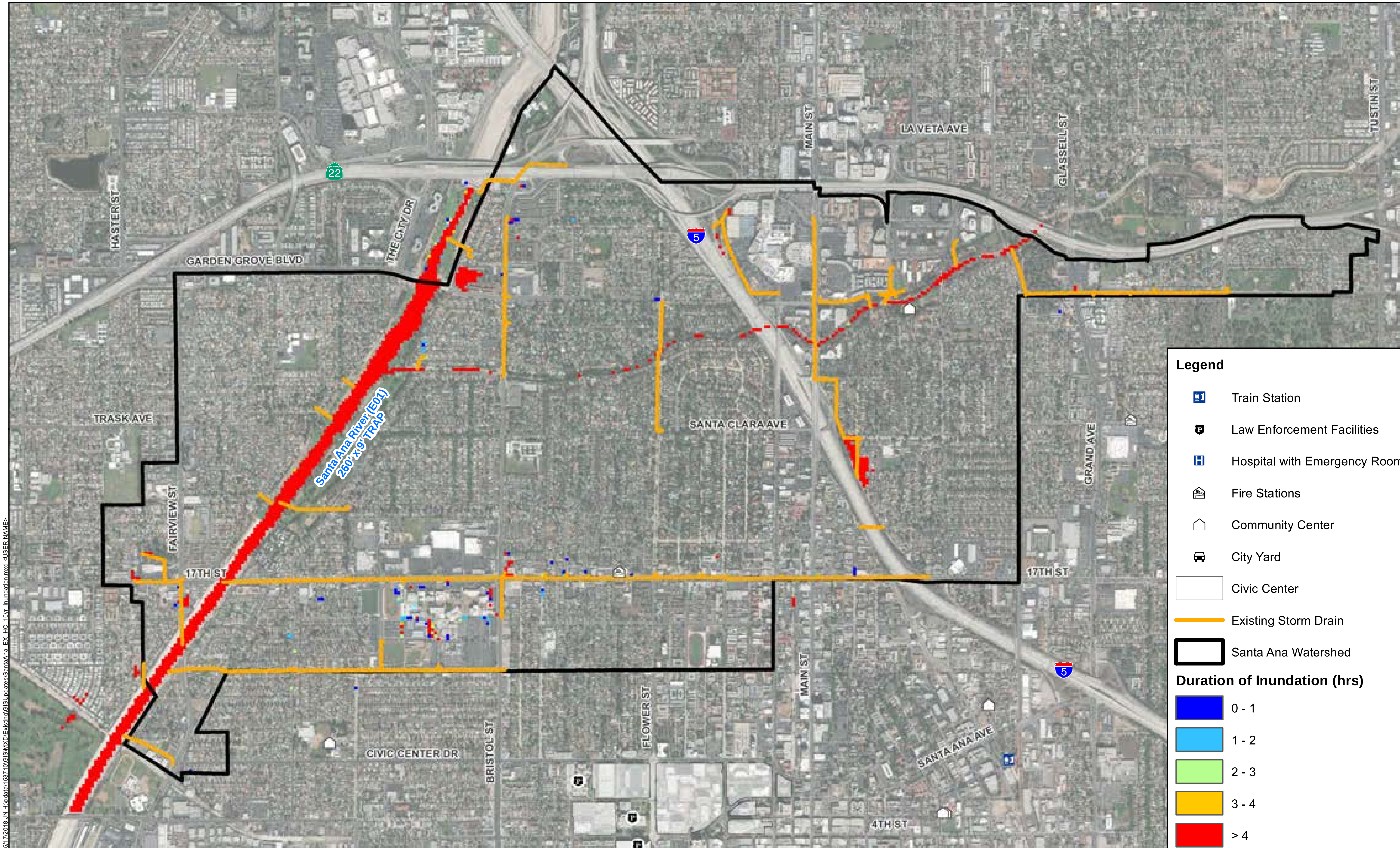
Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - Maximum Flooded Depth Map
100- year Existing Condition

Figure 8-3



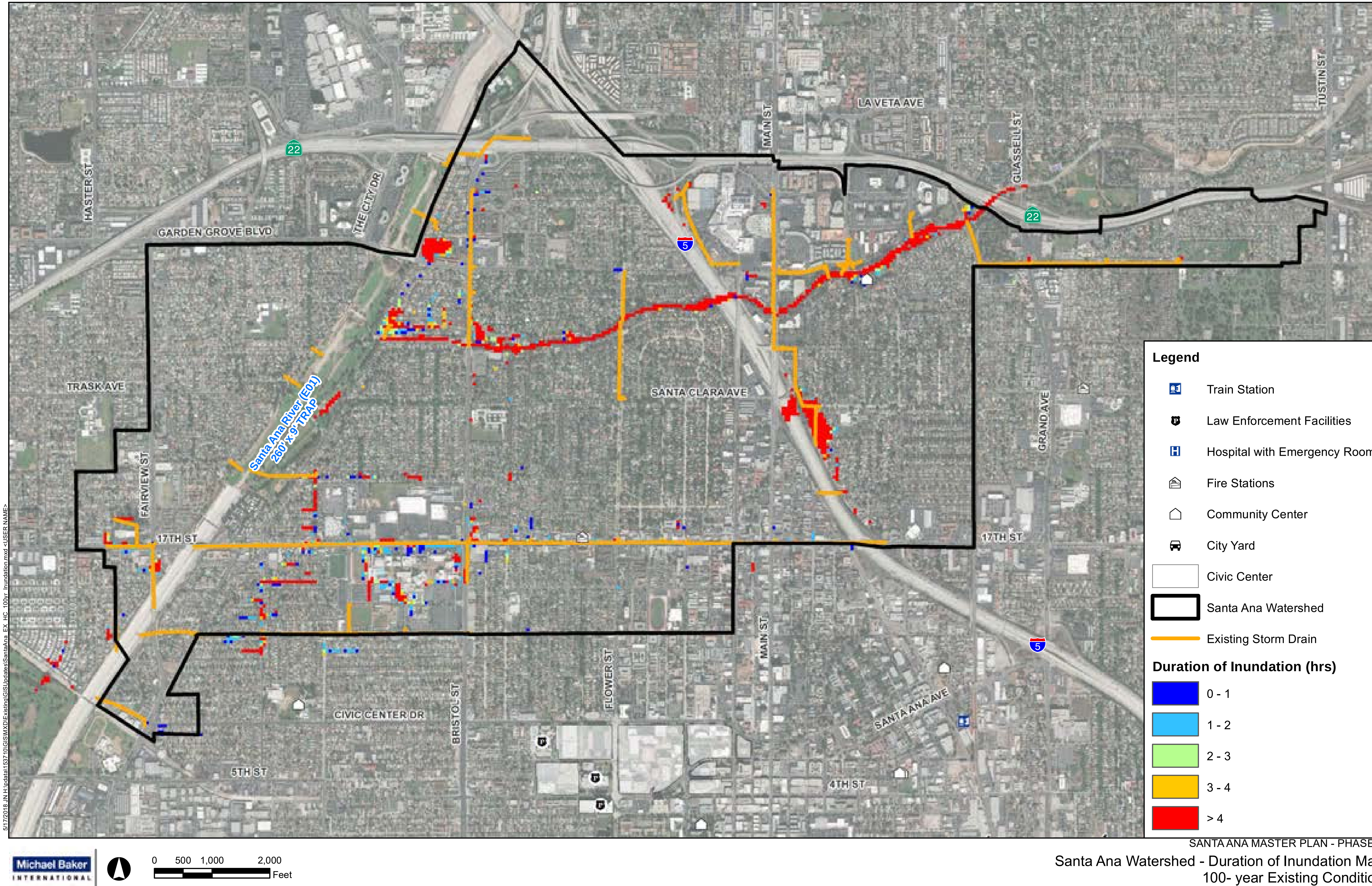
Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - Duration of Inundation Map
10- year Existing Condition

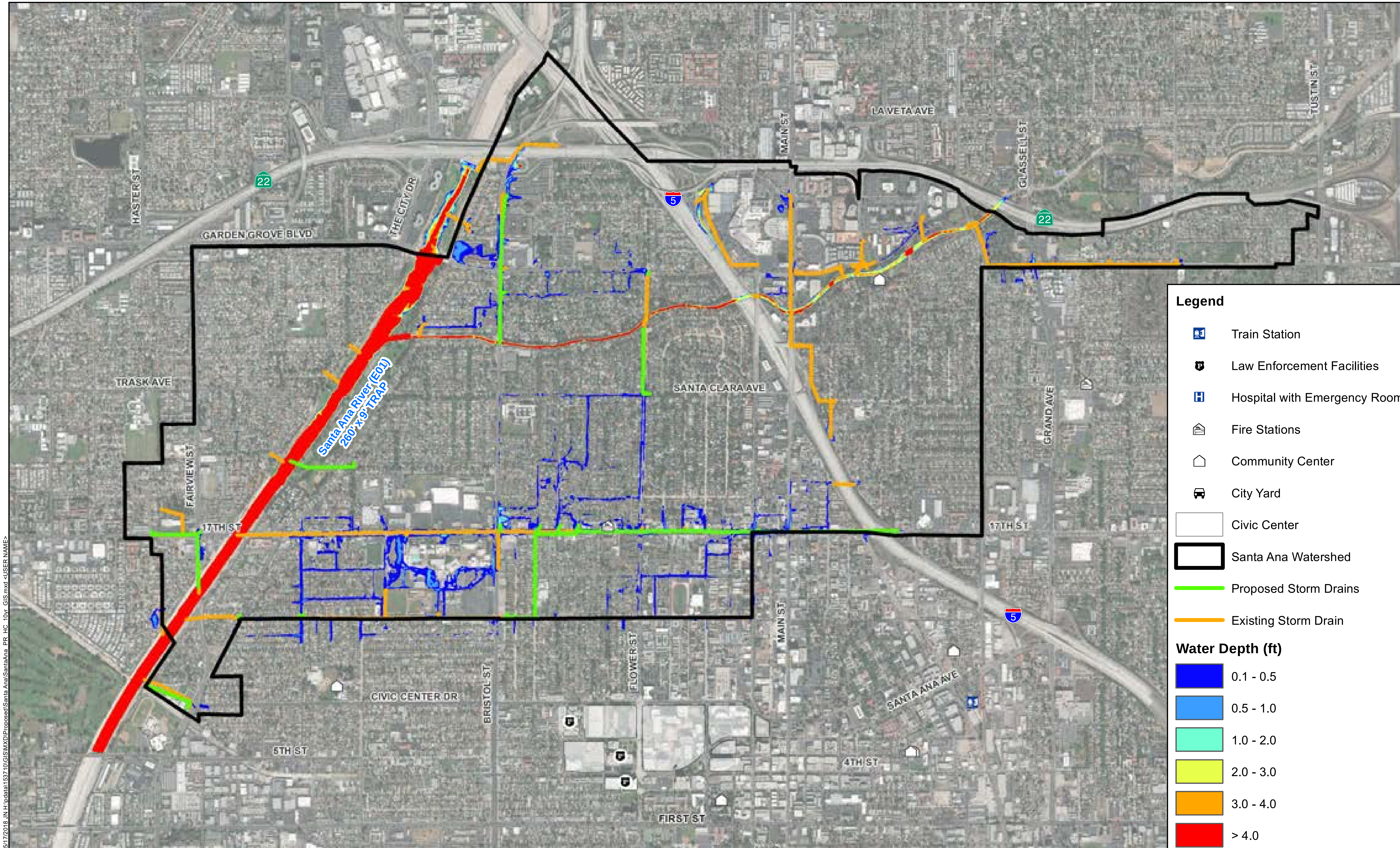
Figure 8-4



SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - Duration of Inundation Map
100- year Existing Condition

Figure 8-5



Michael Baker INTERNATIONAL

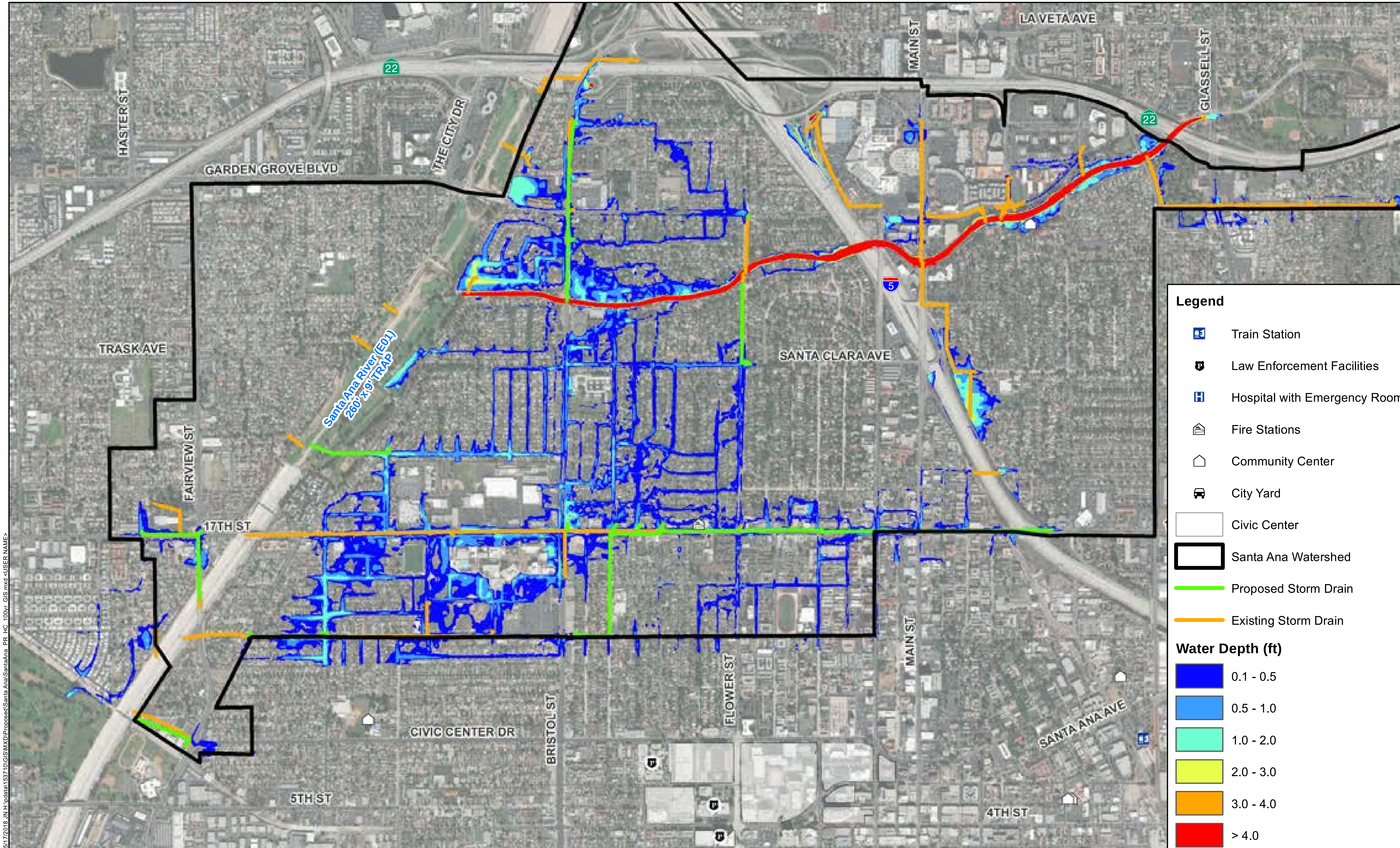
0 500 1,000 2,000 Feet

Source:

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - Maximum Flooded Depth Map
10- year Proposed Condition

Figure 8-6



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Michael Baker INTERNATIONAL

Source:

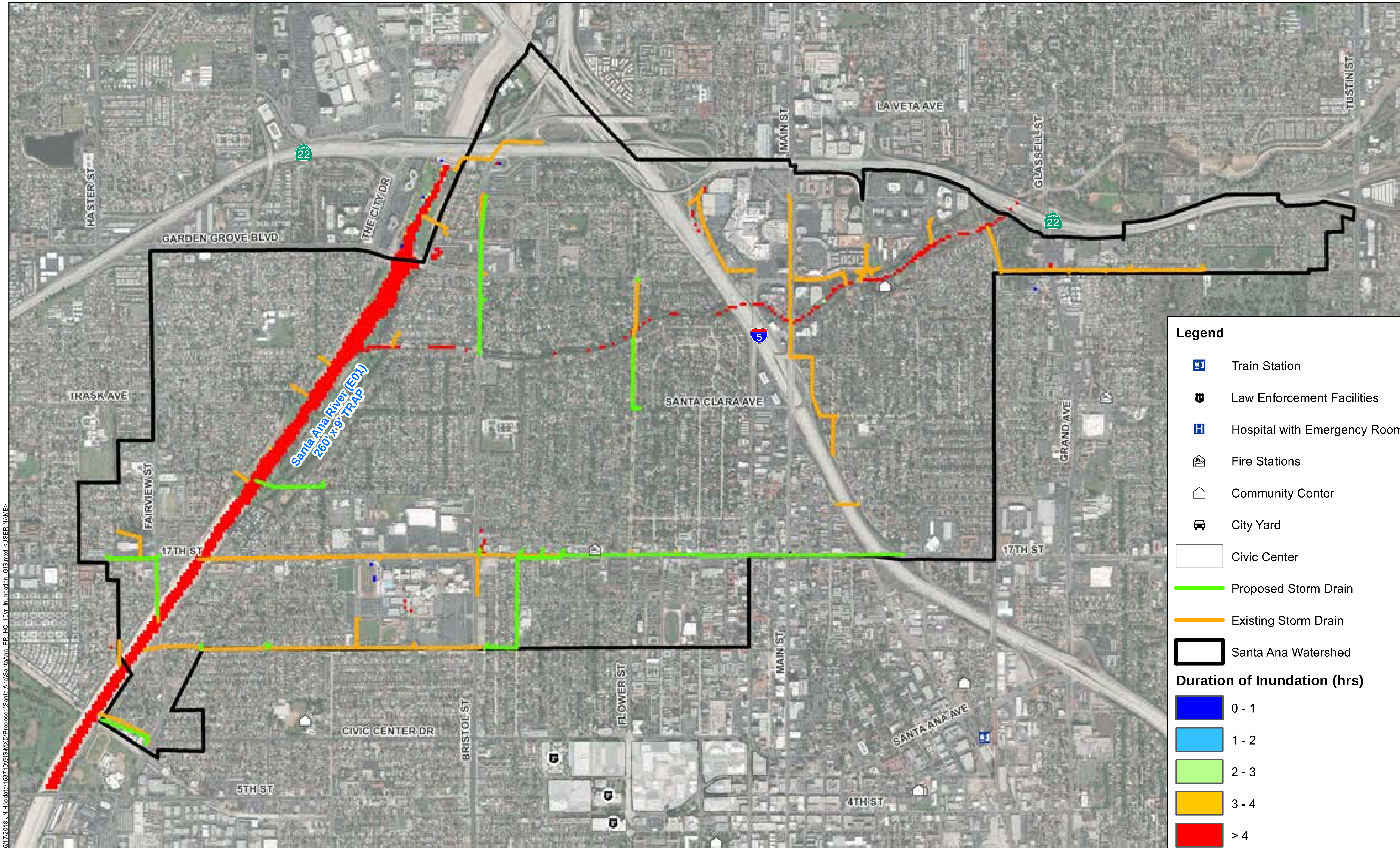
0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - Maximum Flooded Depth Map

100- year Proposed Condition

Figure 8-7



Michael Baker INTERNATIONAL

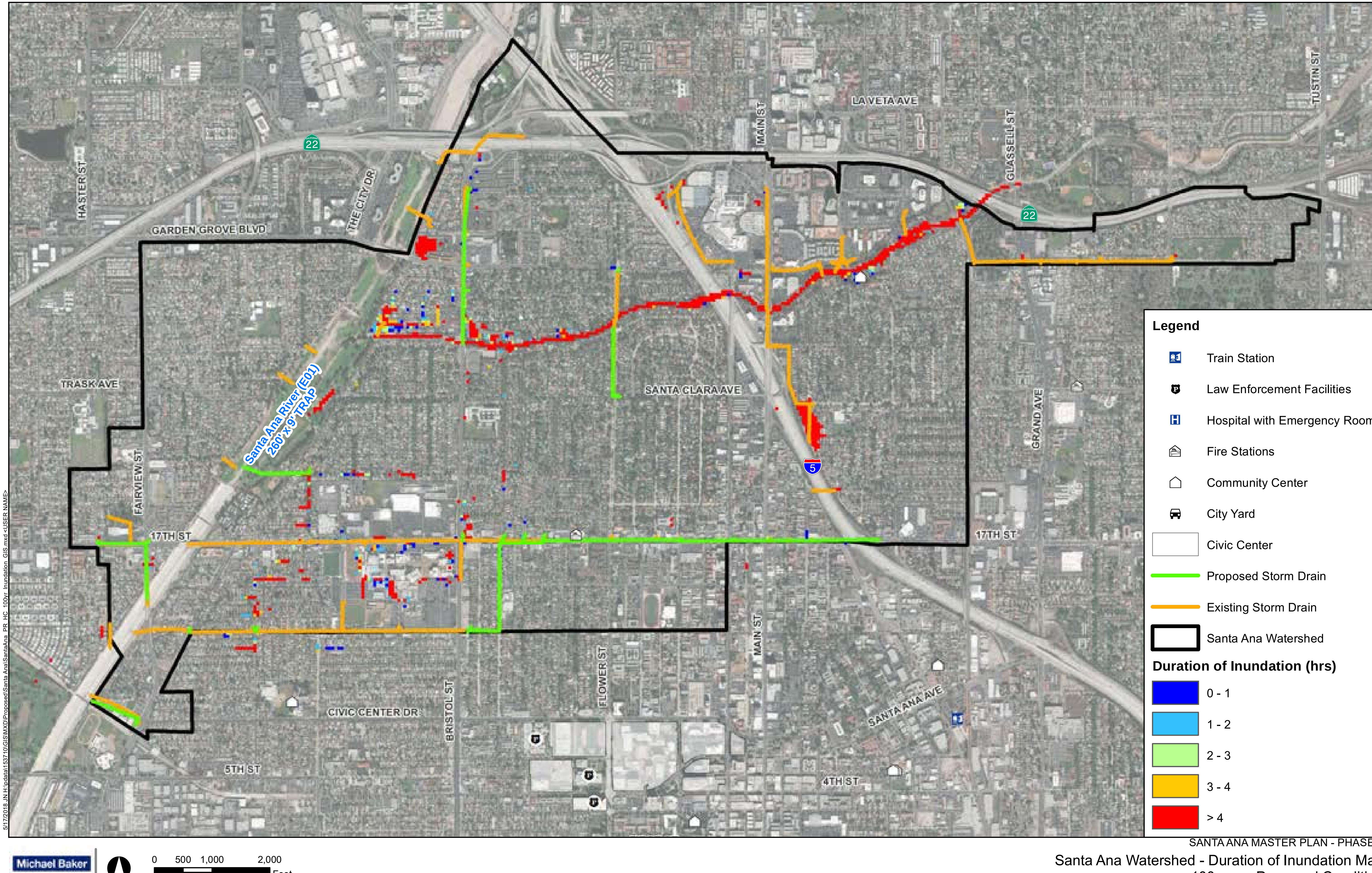
0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - Duration of Inundation Map

10- year Proposed Condition

Figure 8-8

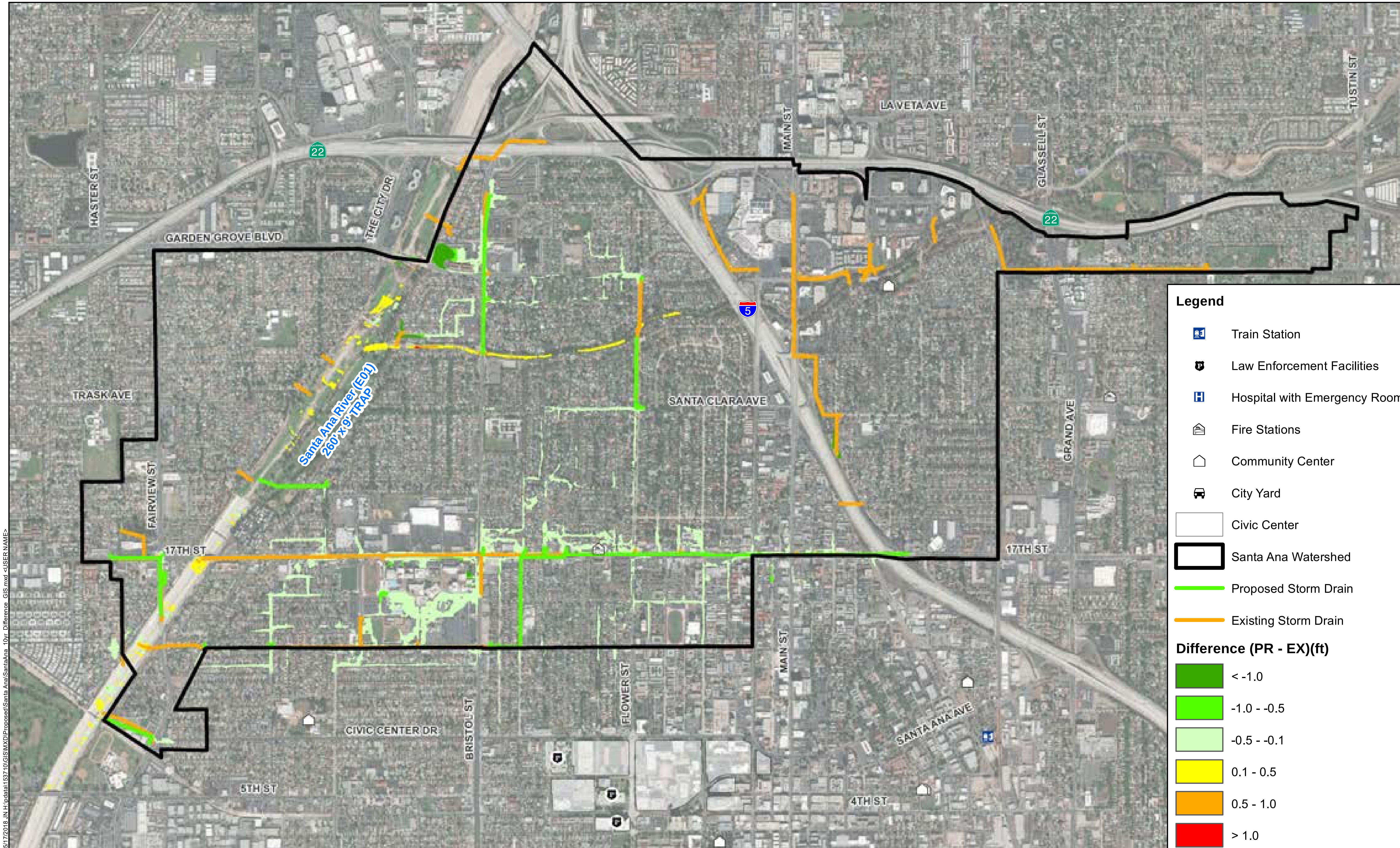


Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - Duration of Inundation Map
100- year Proposed Condition

Figure 8-9



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Michael Baker INTERNATIONAL

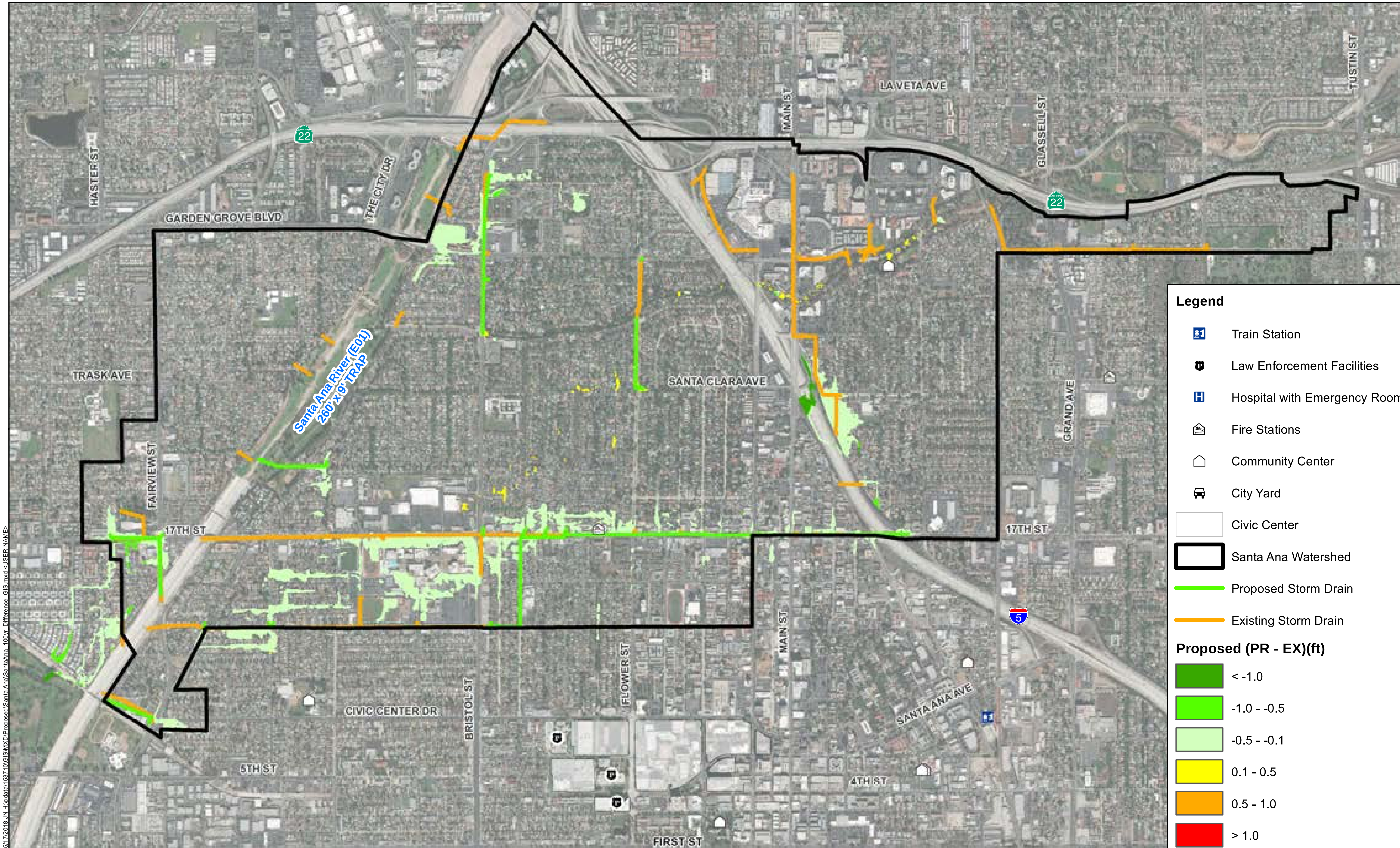
0 500 1,000 2,000 Feet

Source:

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - 10- year Difference Map

Figure 8-10



0 500 1,000 2,000 Feet

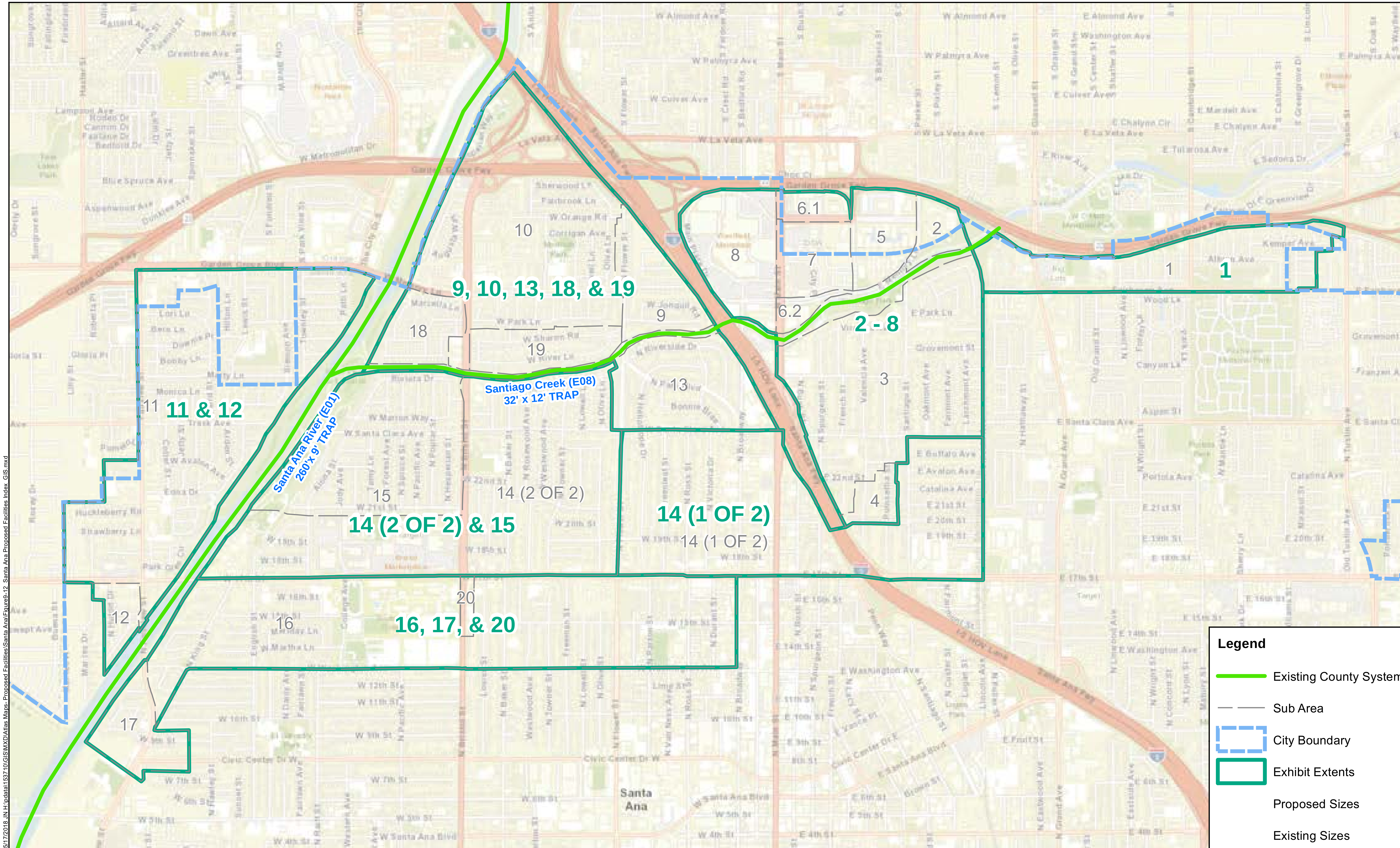
Source:

Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Santa Ana Watershed - 100- year Difference Map

Figure 8-11

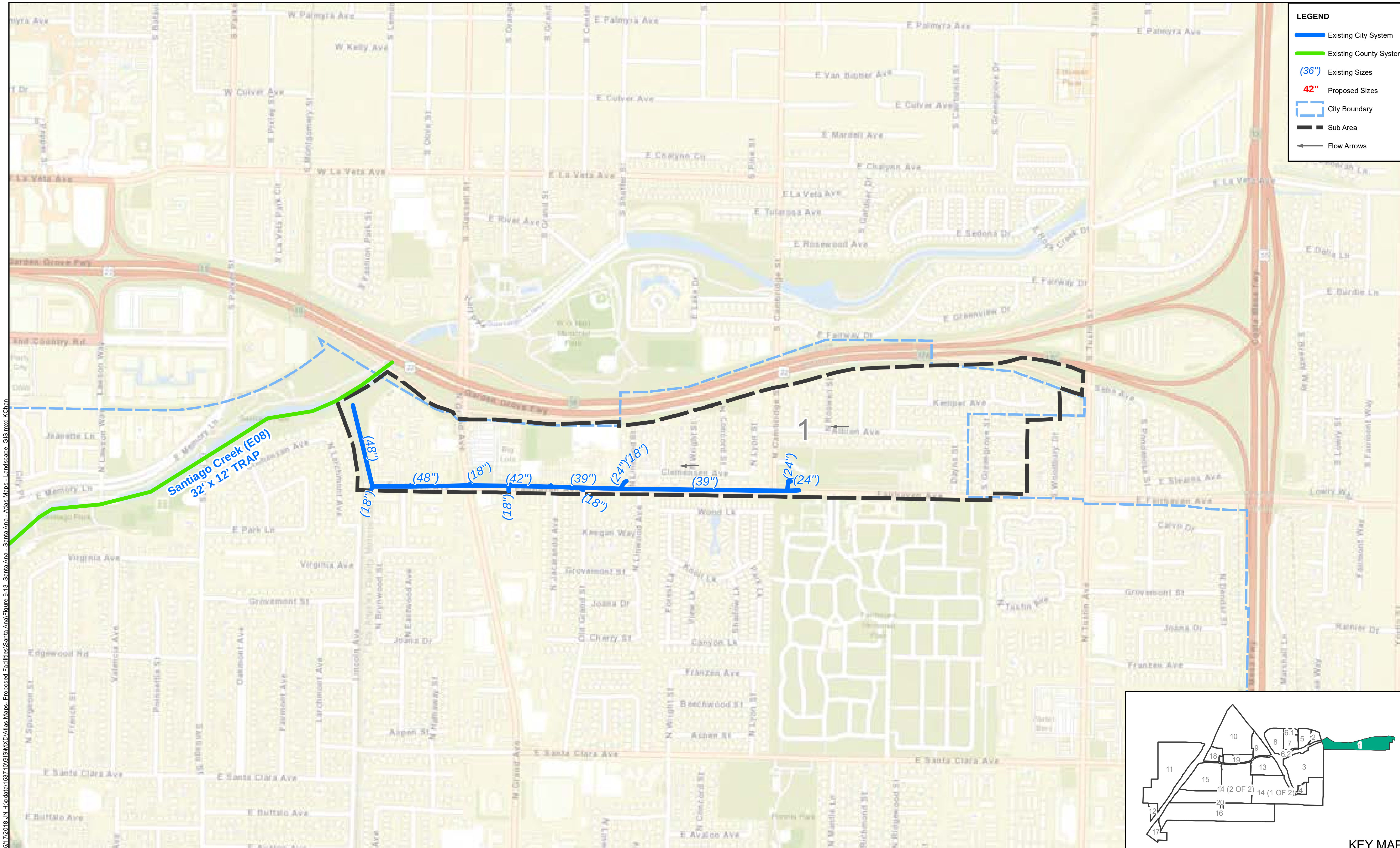


Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA ANA WATERSHED

Proposed Facilities - Exhibits Index Map

Figure 8-12



5/17/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps - Proposed Facilities\Santa Ana\Figure 9-13_Santa Ana - Santa Ana - Atlas Maps - Landscape_GIS.mxd KChan

Michael Baker INTERNATIONAL

N

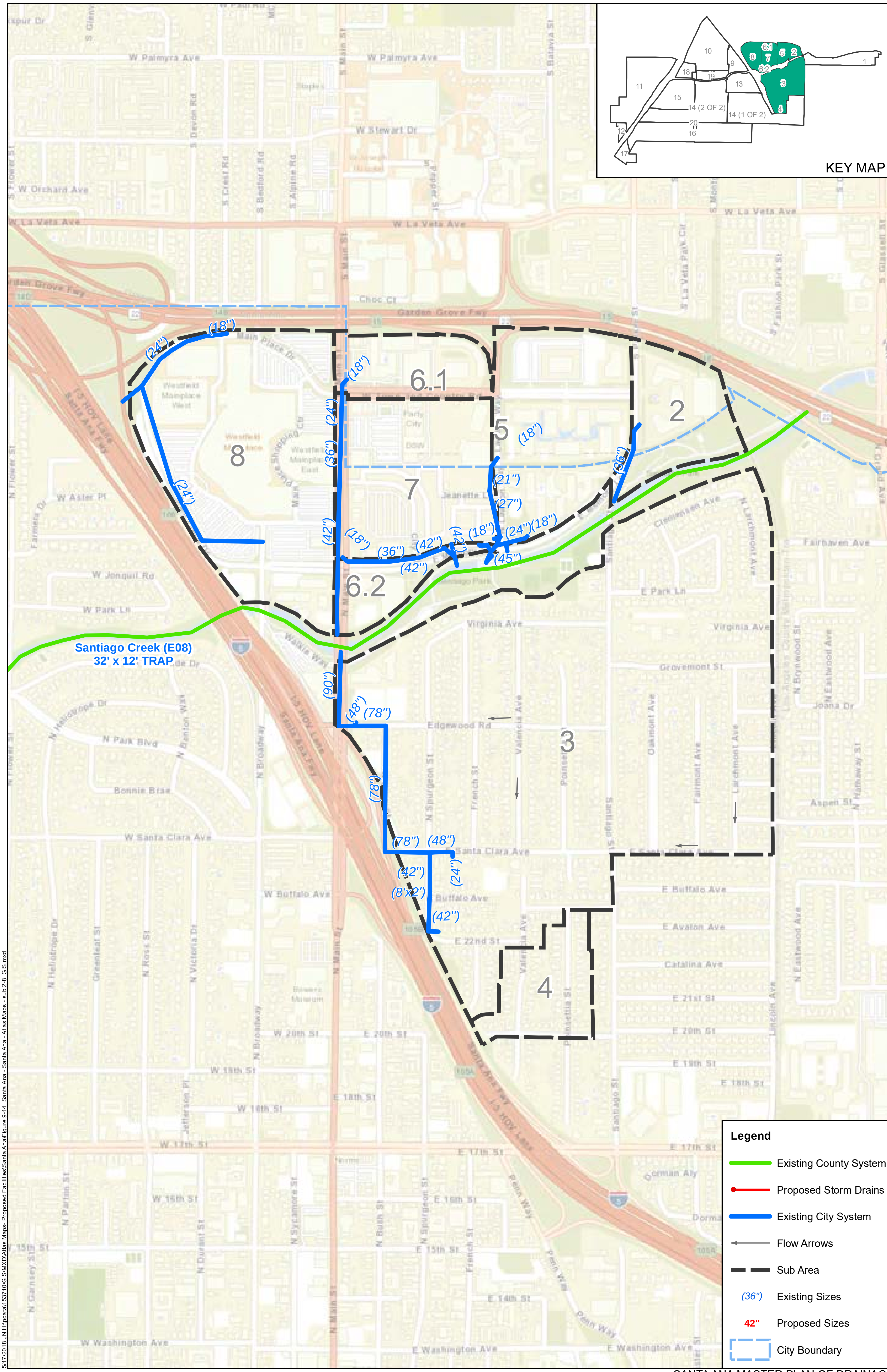
0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE

SANTA ANA WATERSHED

PROPOSED FACILITIES - SUB AREA 1

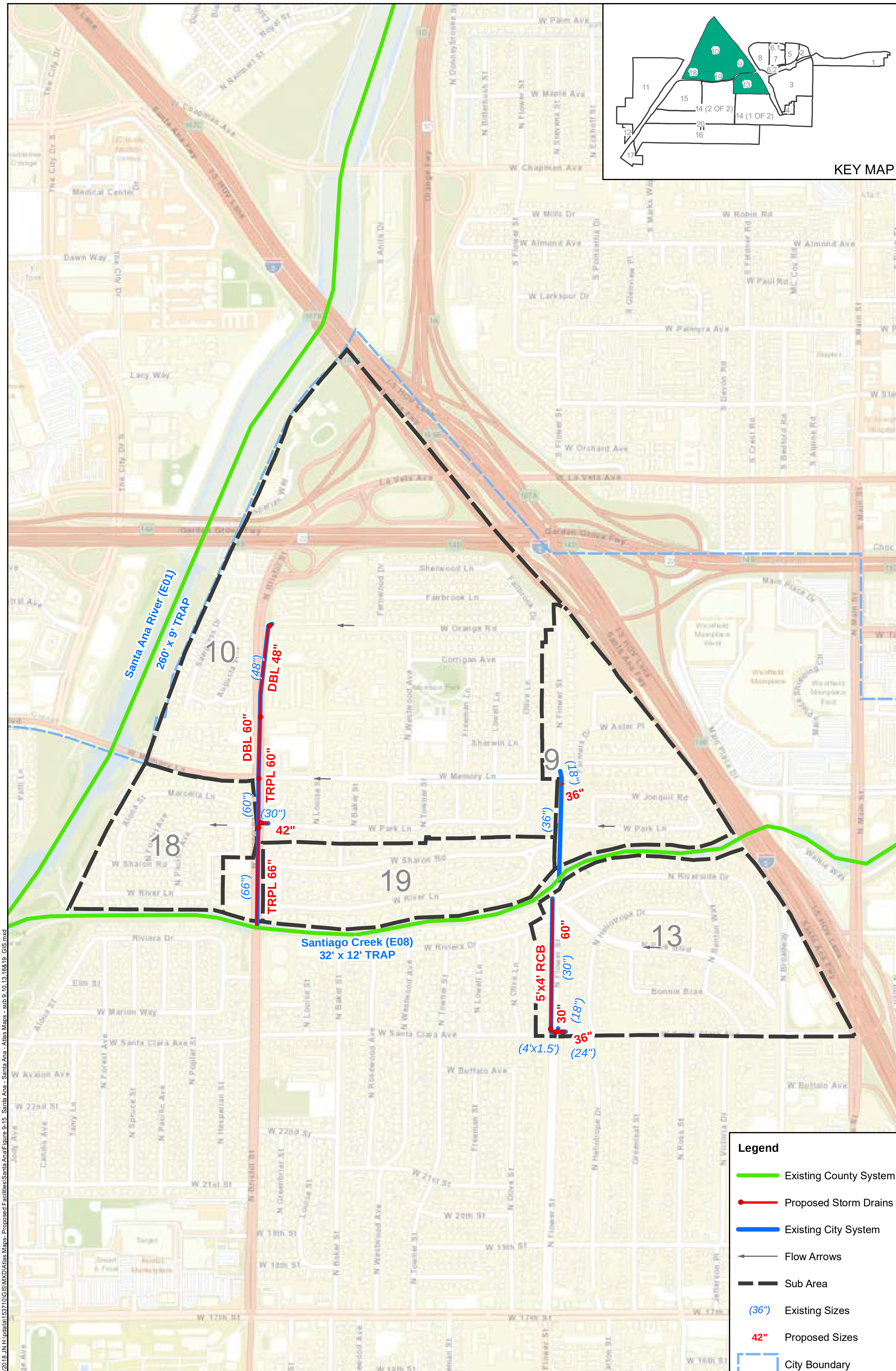
FIGURE 8-13



SANTA ANA MASTER PLAN OF DRAINAGE
SANTA ANA WATERSHED

PROPOSED FACILITIES - PROPOSED FACILITIES - SUB AREAS 2 - 8

FIGURE 8-14



0 500 1,000 Feet

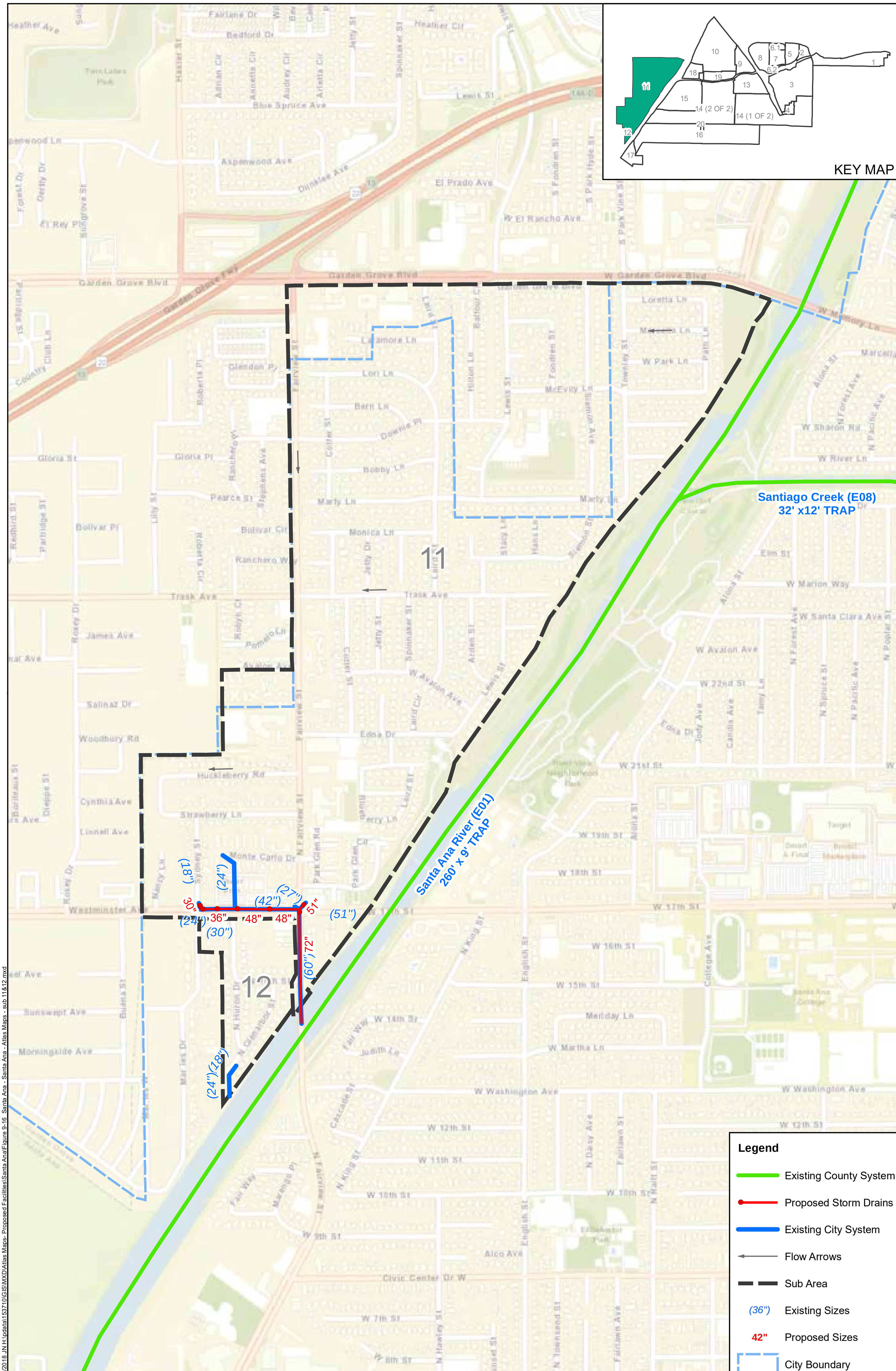
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA ANA WATERSHED

PROPOSED FACILITIES - SUB AREAS 9, 10, 13, 18, & 19

FIGURE 8-15

5/17/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps- Proposed Facilities\Santa Ana\Figure 9-15_Santa Ana - Santa Ana - Atlas Maps - sub 9,10,13,18&19_GIS.mxd



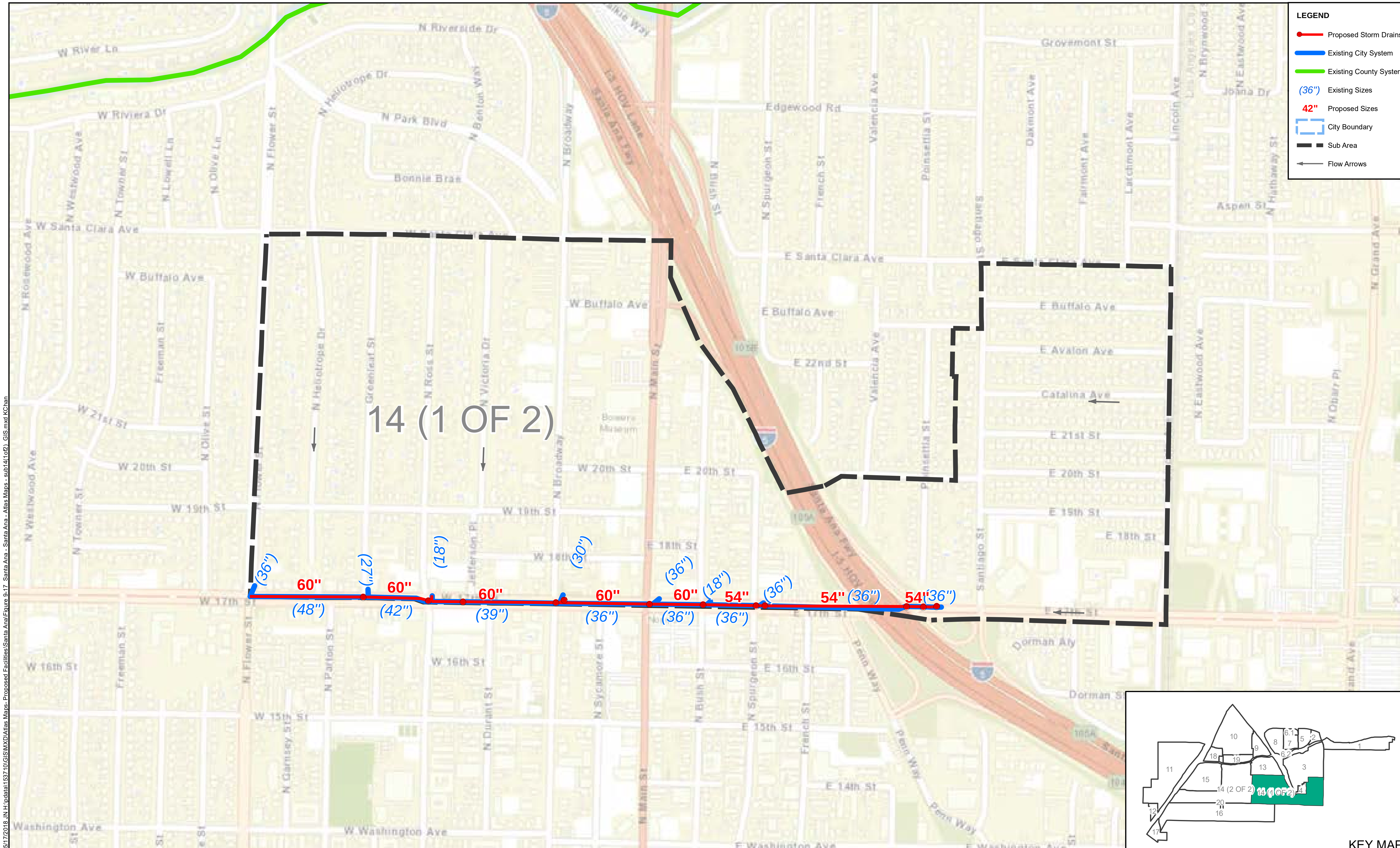
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA ANA WATERSHED

PROPOSED FACILITIES - SUB AREAS 11 & 12

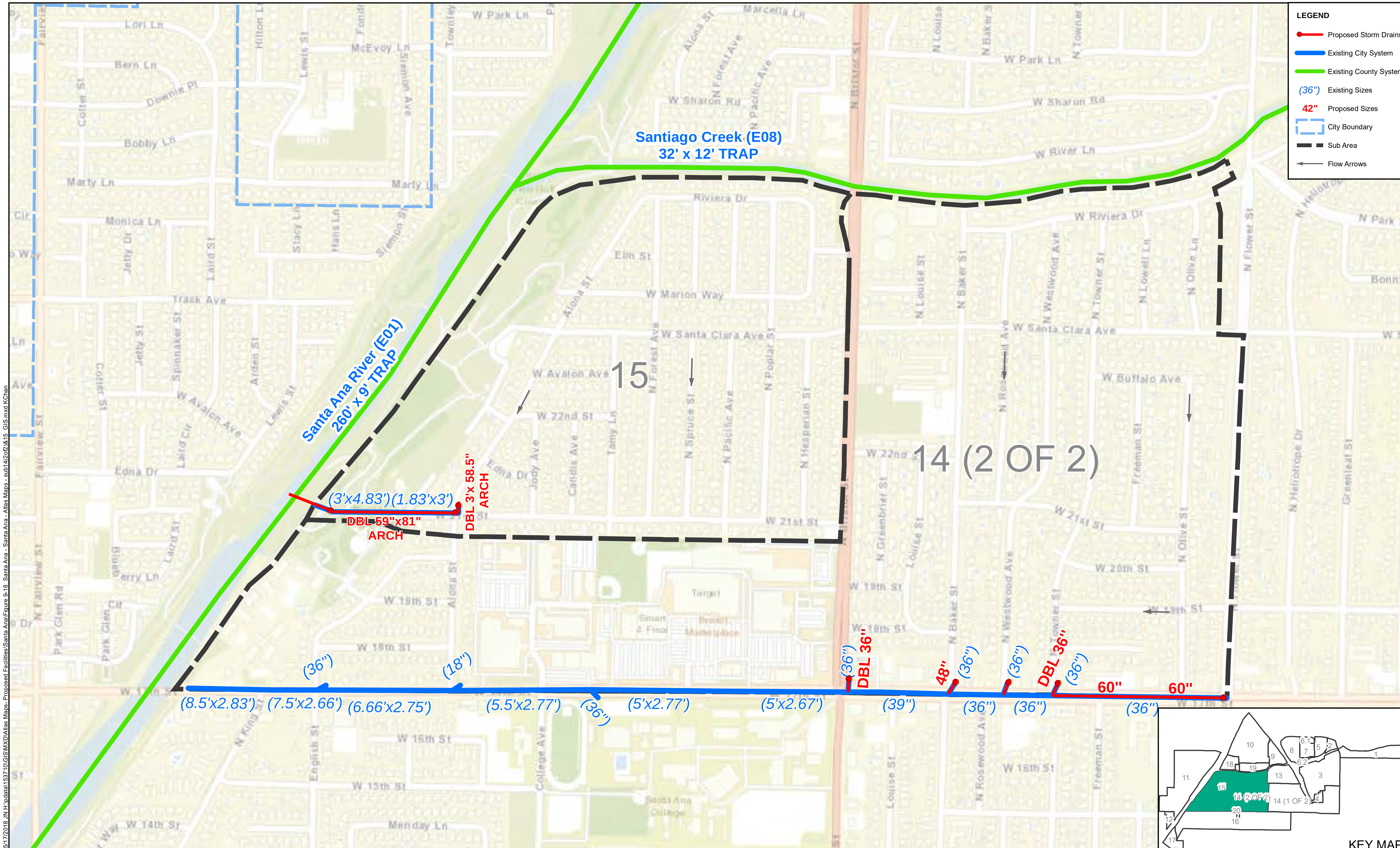
FIGURE 8-16

5/17/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps- Proposed Facilities\Santa Ana\Figure 9-16_Santa Ana - Santa Ana - Atlas Maps - sub 11&12.mxd



PROPOSED FACILITIES - SUB AREA 14 (1 OF 2)

FIGURE 8-17



Michael Baker INTERNATIONAL

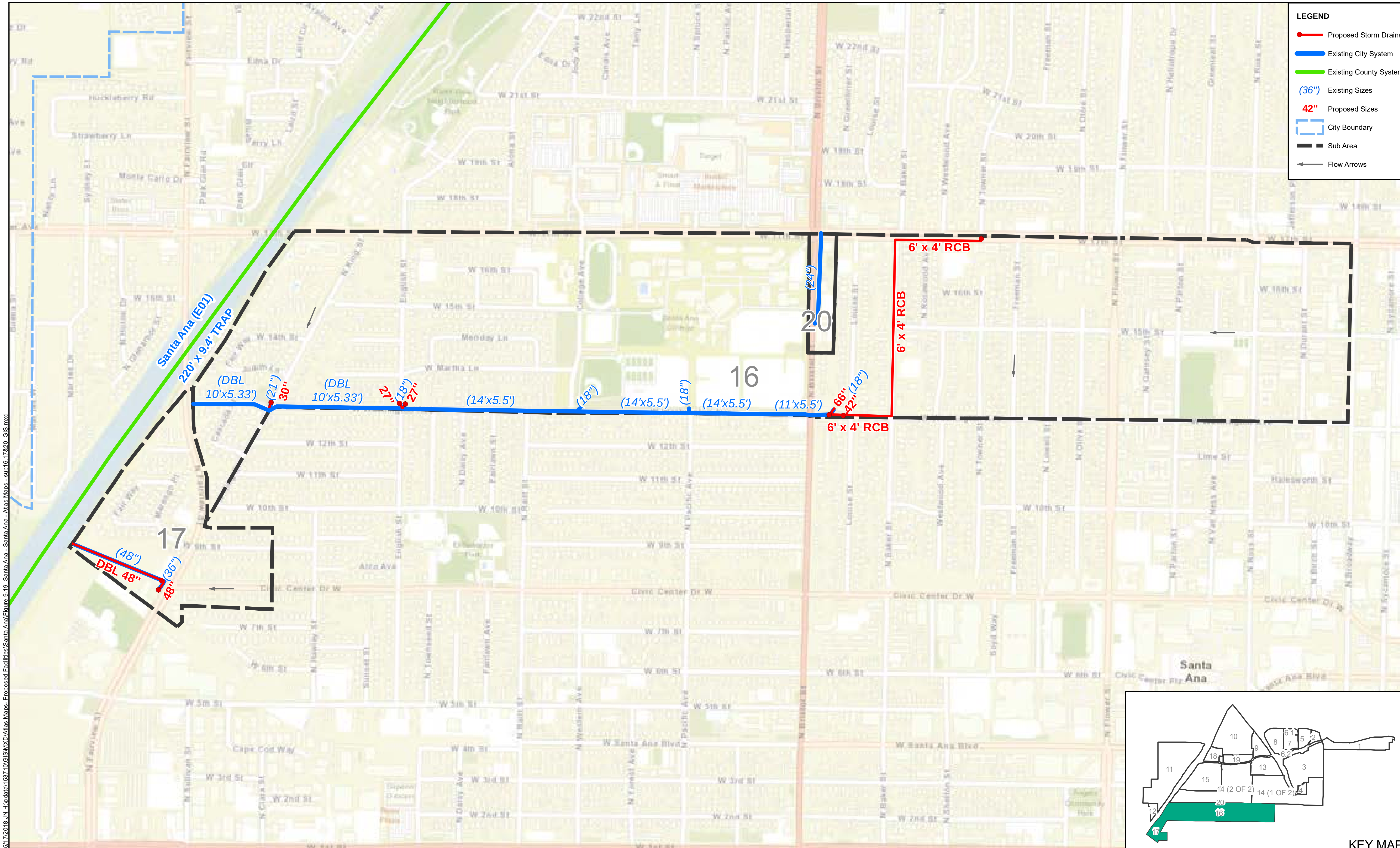
N

0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA ANA WATERSHED

PROPOSED FACILITIES - SUB AREAS 14 (2 OF 2) & 15

FIGURE 8-18



Michael Baker INTERNATIONAL

N

0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE

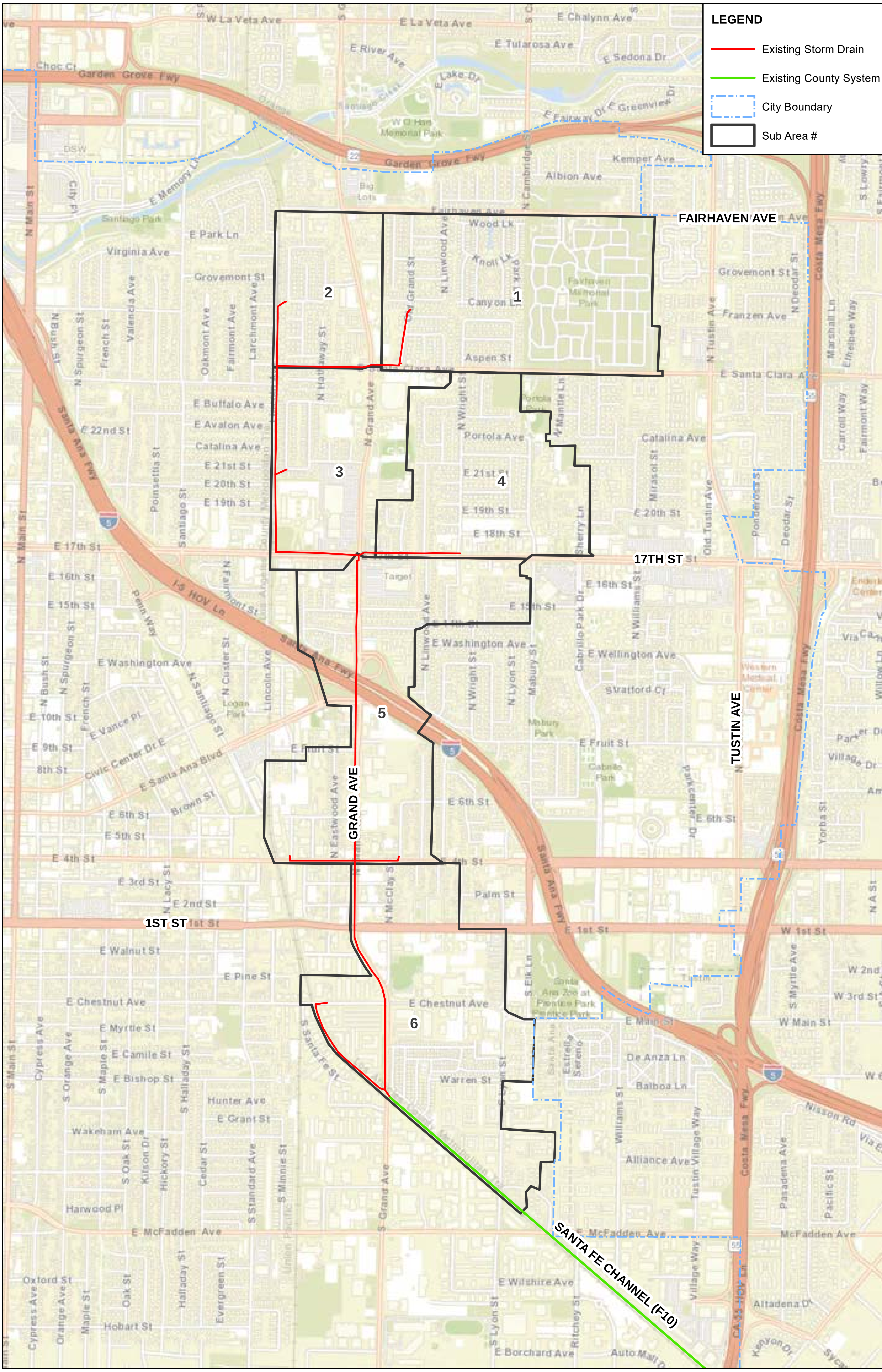
SANTA ANA WATERSHED

PROPOSED FACILITIES - SUB AREAS 16, 17, & 20

FIGURE 8-19

5/17/2018 JN H:\pdata\153710\GIS\MXD\Atlas Maps- Proposed Facilities\Santa Ana\Figure 9-19_Santa Ana - Santa Ana - Atlas Maps - sub16,17&20_GIS.mxd

SANTA FE GRAND EXHIBITS



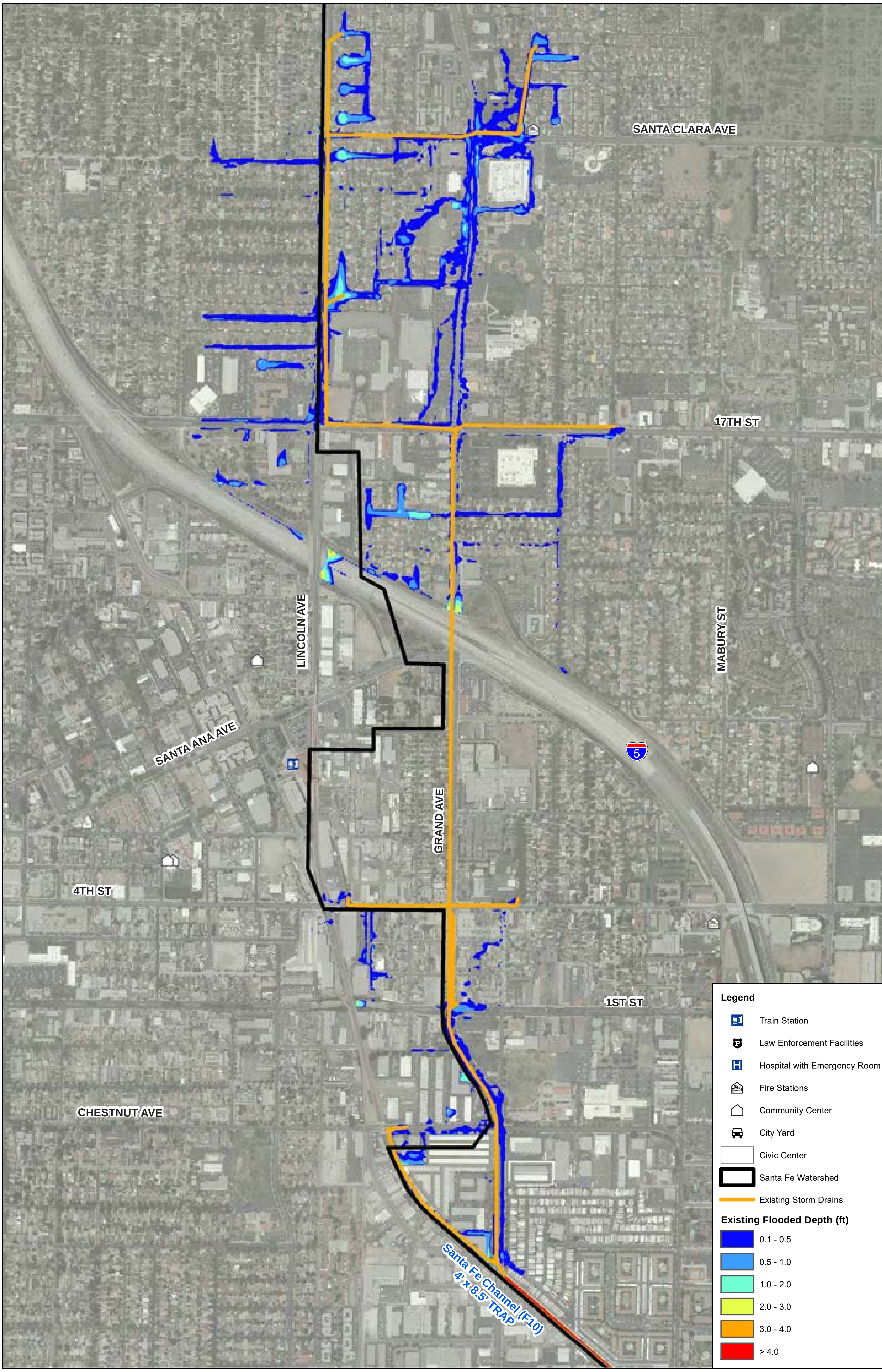
0 1,000 2,000 Feet

Source: Streets Basemap - Esri

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA FE GRAND WATERSHED

Watershed Subarea Map

Figure 9-1



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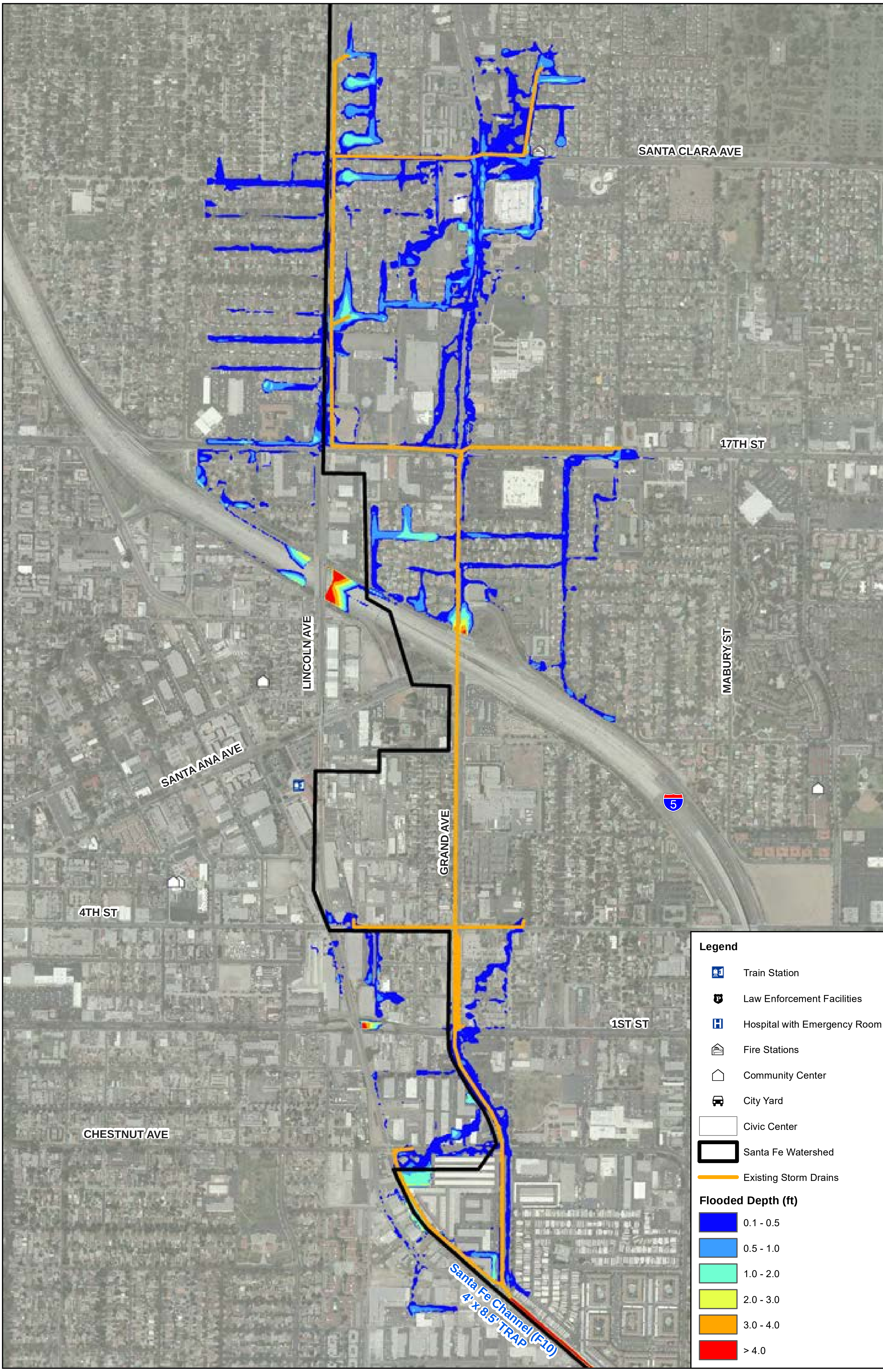
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Grand Watershed - Maximum Flooded Depth Map

10- year Existing Condition

Figure 9-2



0 500 1,000 Feet

Michael Baker INTERNATIONAL

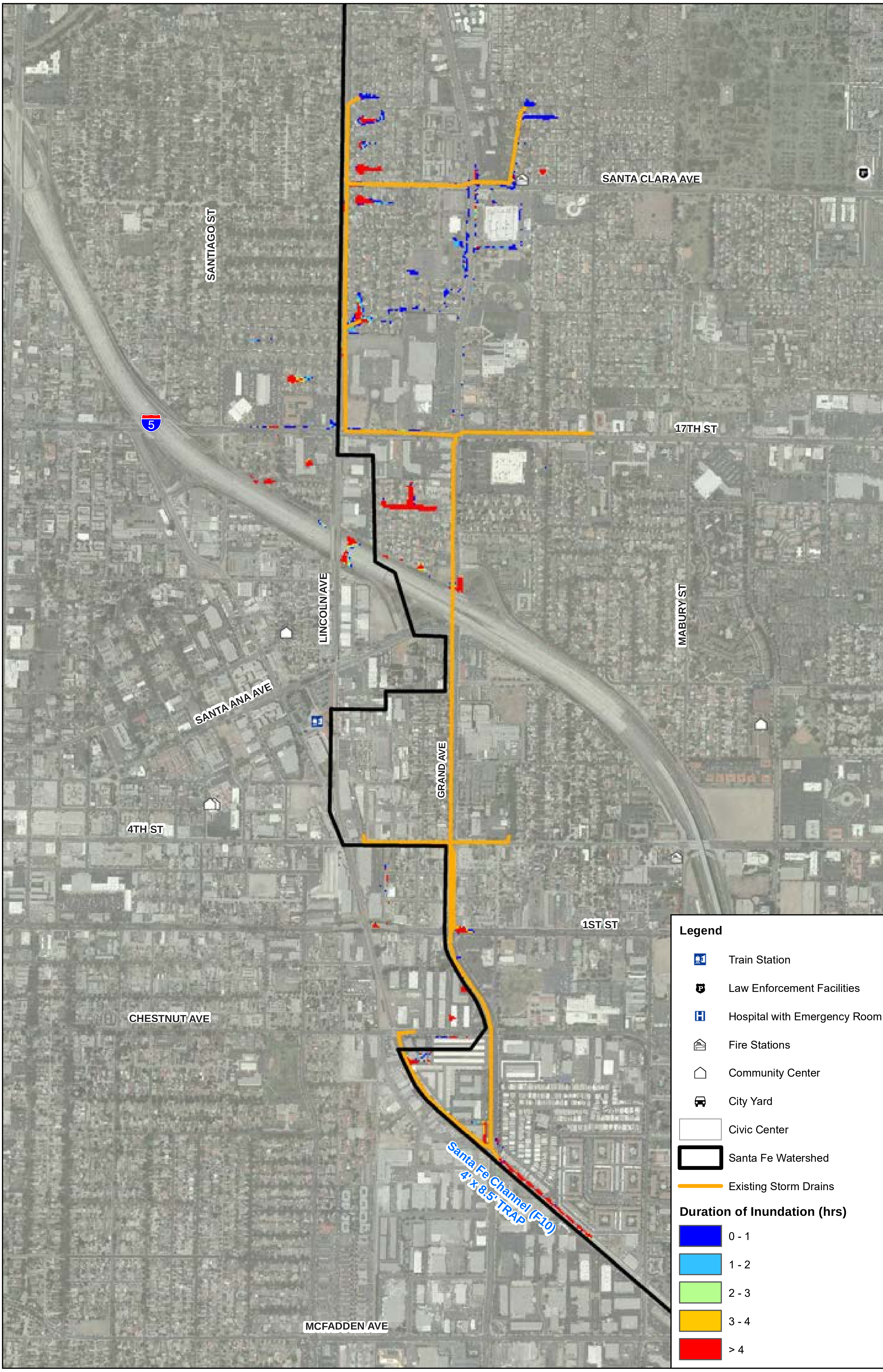
SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Grand Watershed - Maximum Flooded Depth Map

100- year Existing Condition

Figure 9-3

5/17/2018 JN H:\pdata\153710\GIS\MXD\Existing\Santa Fe Grand\Santa Fe Grand_EX_HC_100yr_GIS.mxd <USER NAME>



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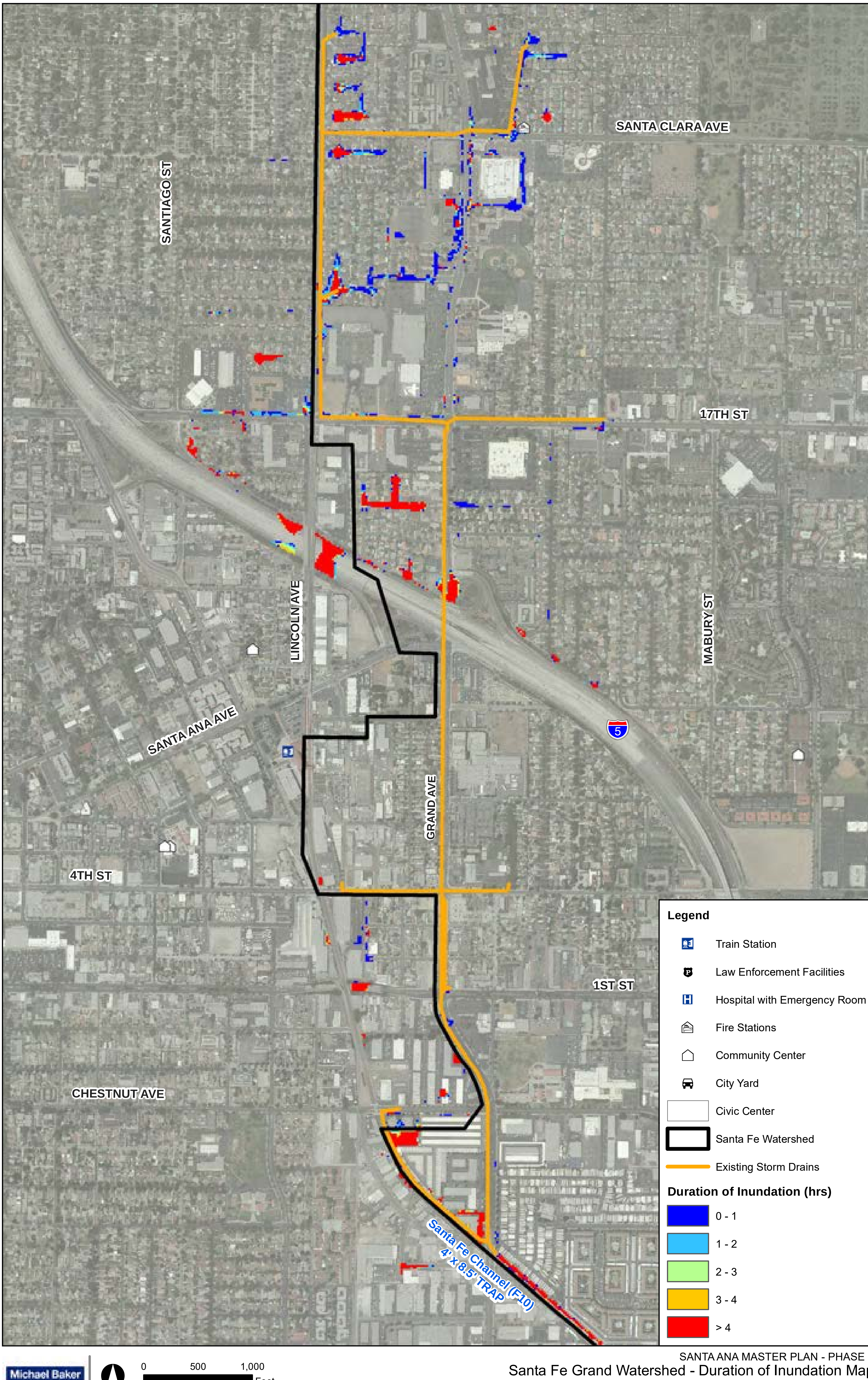
Michael Baker INTERNATIONAL

0 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2
Santa Fe Grand Watershed - Duration of Inundation Map
10- year Existing Condition
Figure 9-4



SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Grand Watershed - Duration of Inundation Map

100- year Existing Condition

Figure 9-5

Michael Baker INTERNATIONAL

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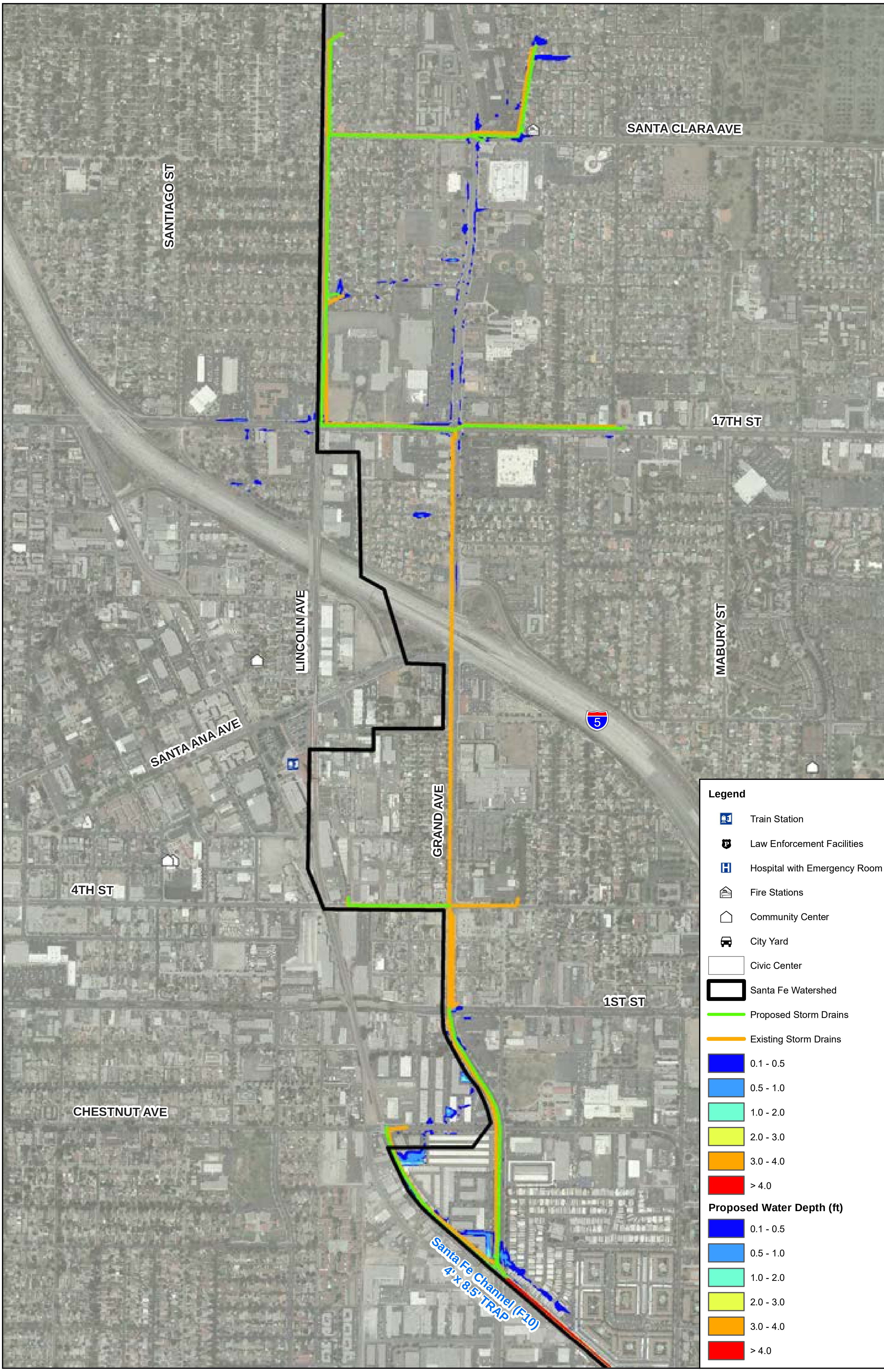

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Michael Baker INTERNATIONAL

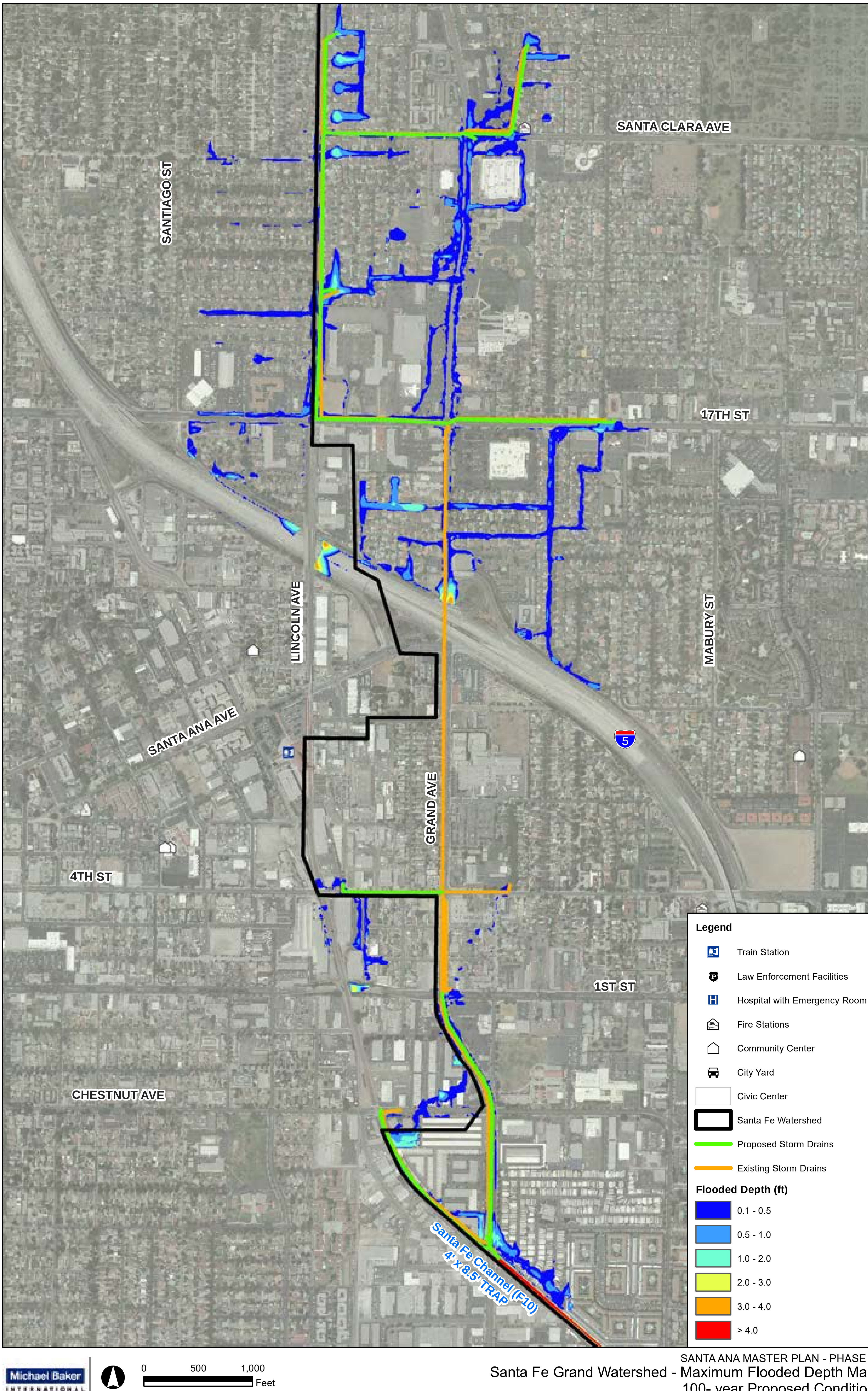
0 250 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Grand Watershed - Maximum Flooded Depth Map

10- year Proposed Condition

Figure 9-6

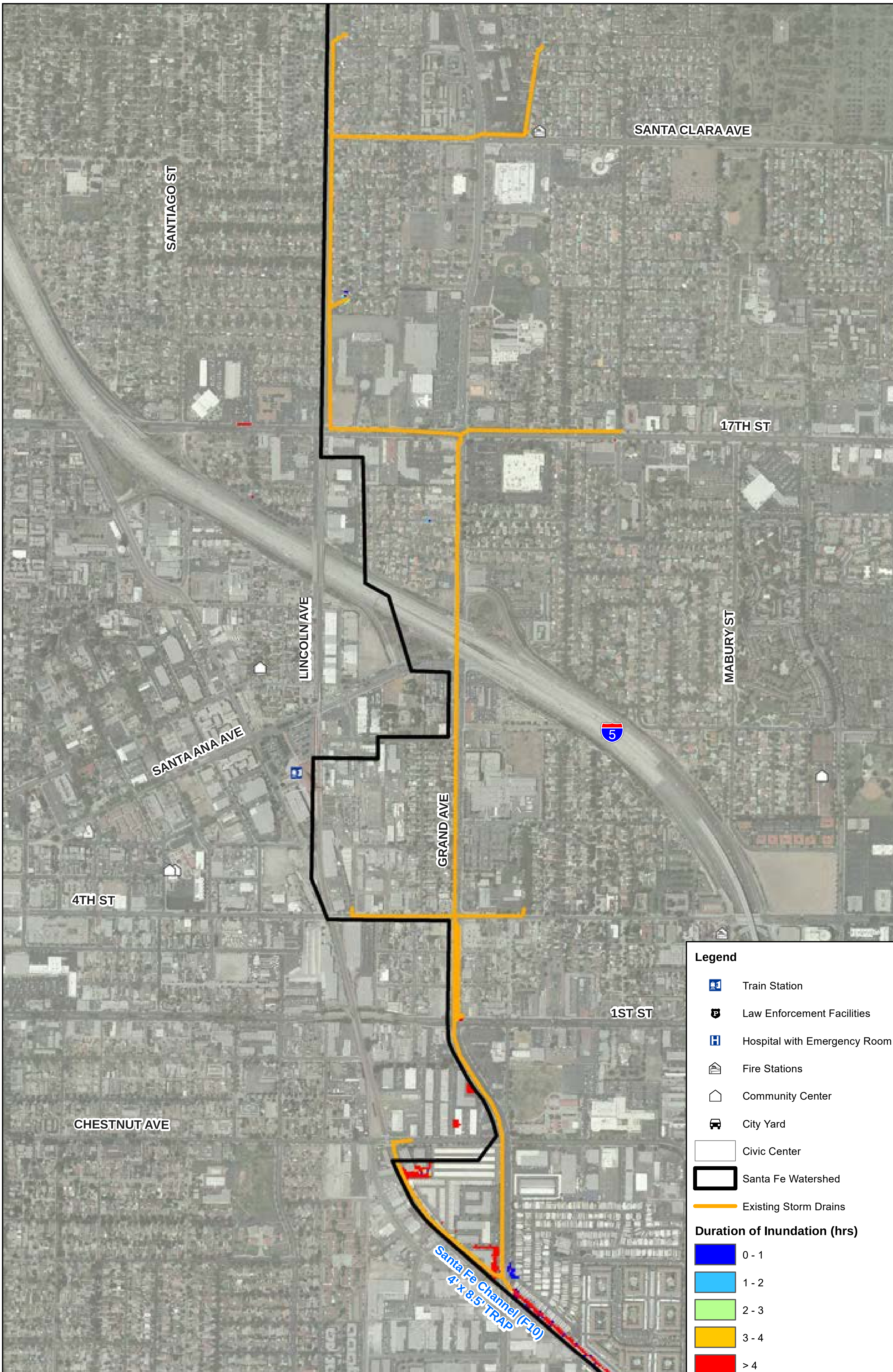


SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Grand Watershed - Maximum Flooded Depth Map

100- year Proposed Condition

Figure 9-7



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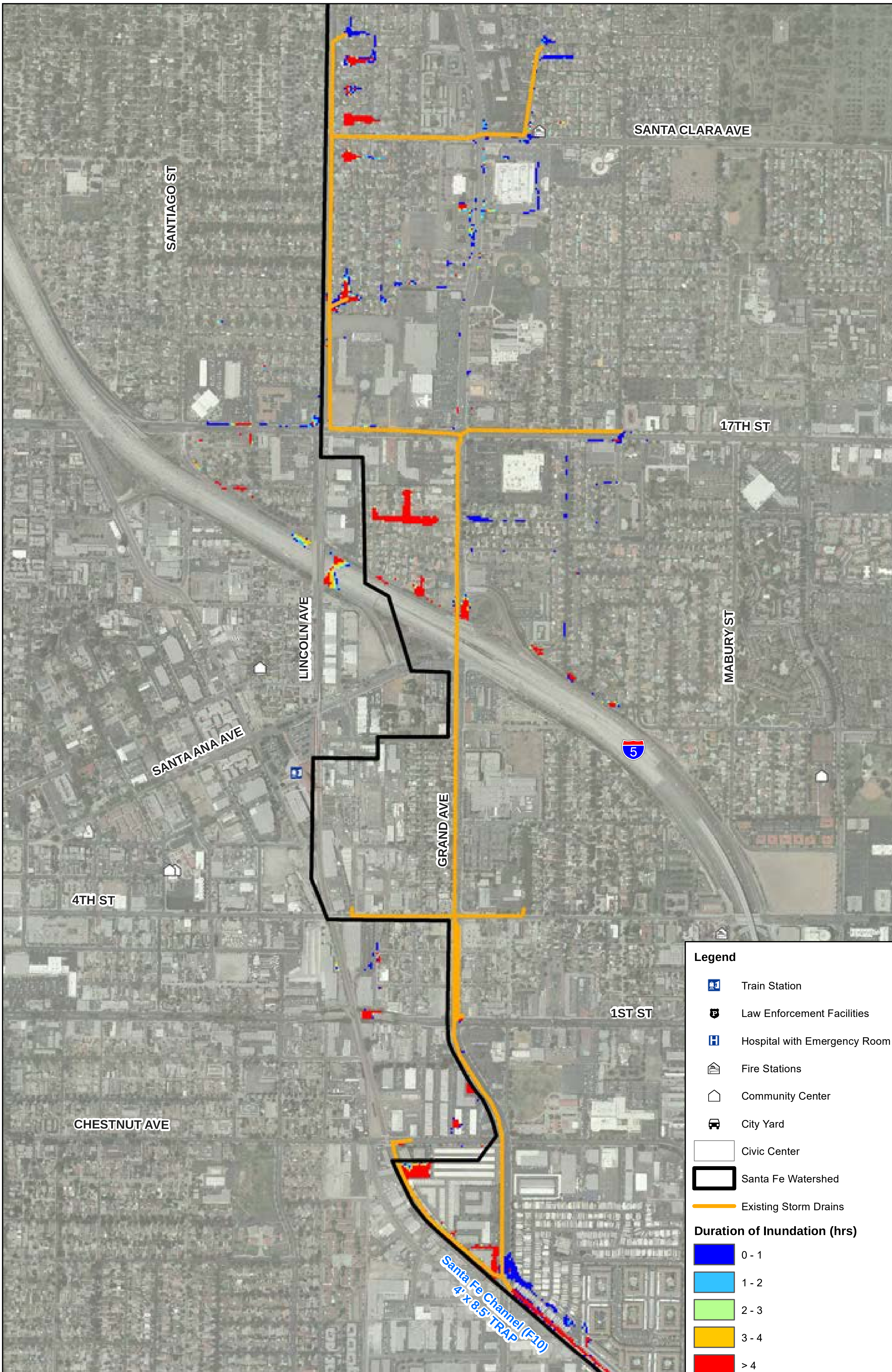
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Grand Watershed - Time of Inundation Map

10- year Proposed Condition

Figure 9-8



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Michael Baker INTERNATIONAL

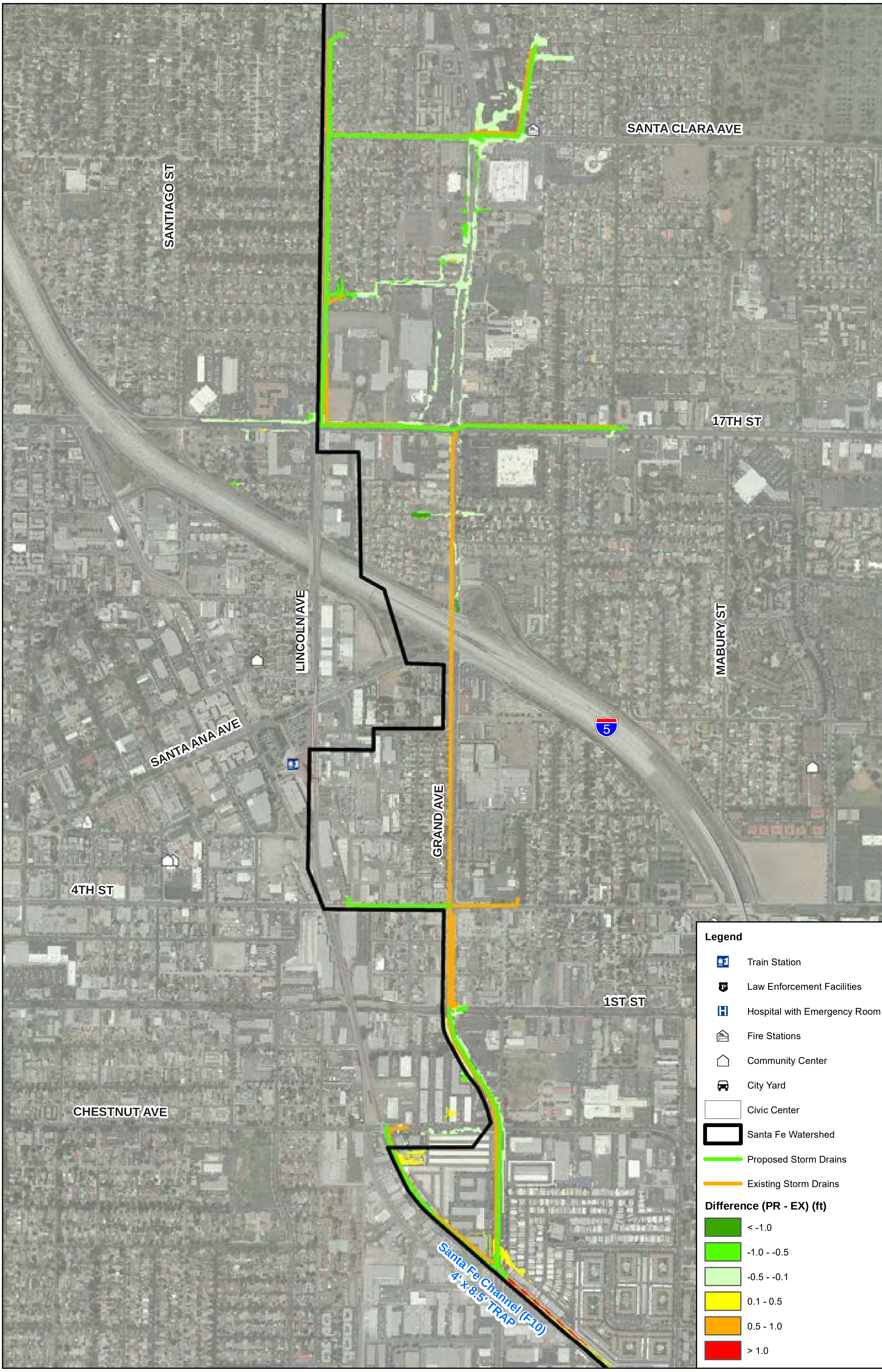
0 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Grand Watershed - Time of Inundation Map

100- year Proposed Condition

Figure 9-9



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Michael Baker INTERNATIONAL

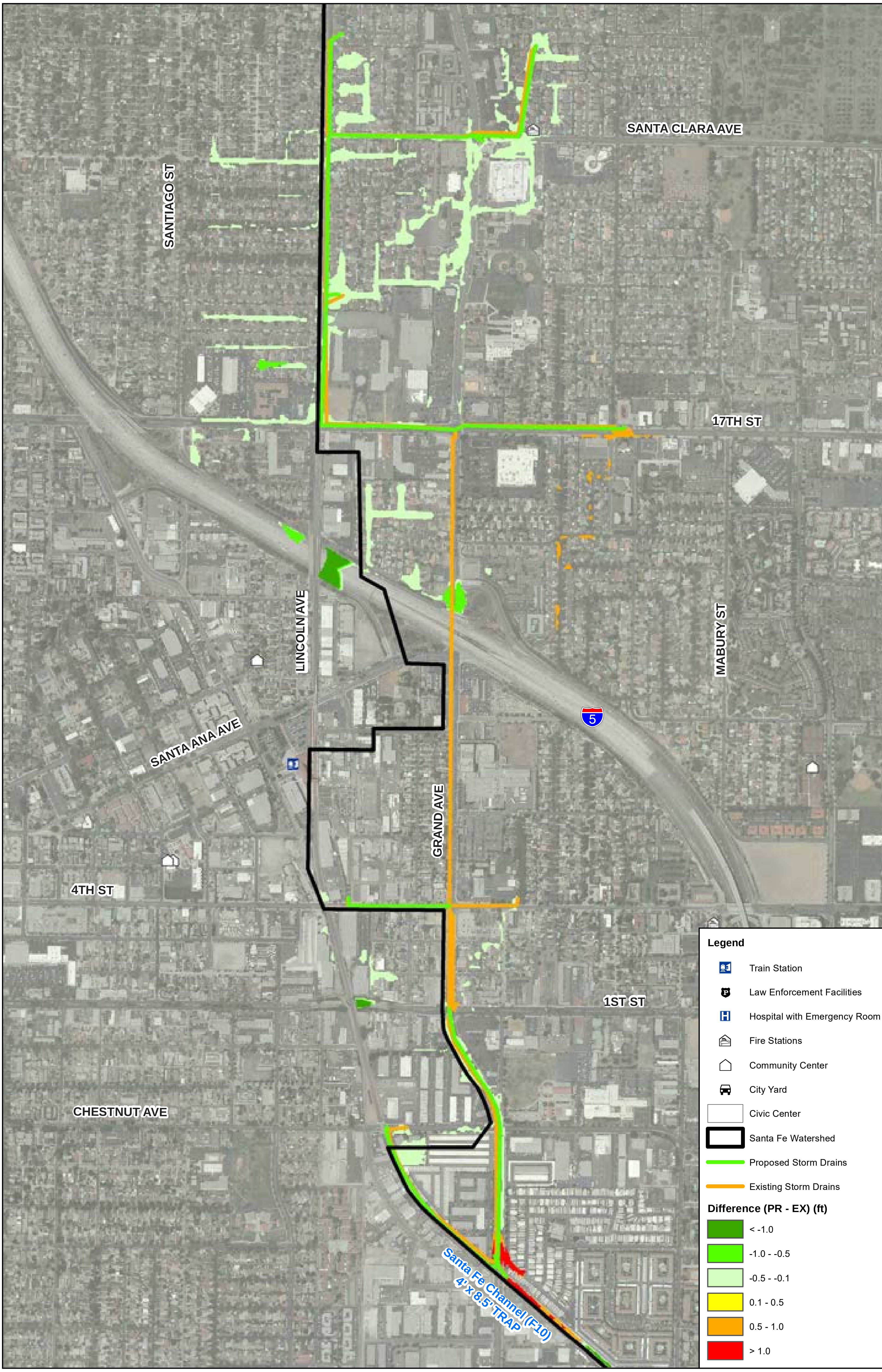
0 500 1,000 Feet

Source:

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Grand Watershed - 10- year Difference Map

Figure 9-10



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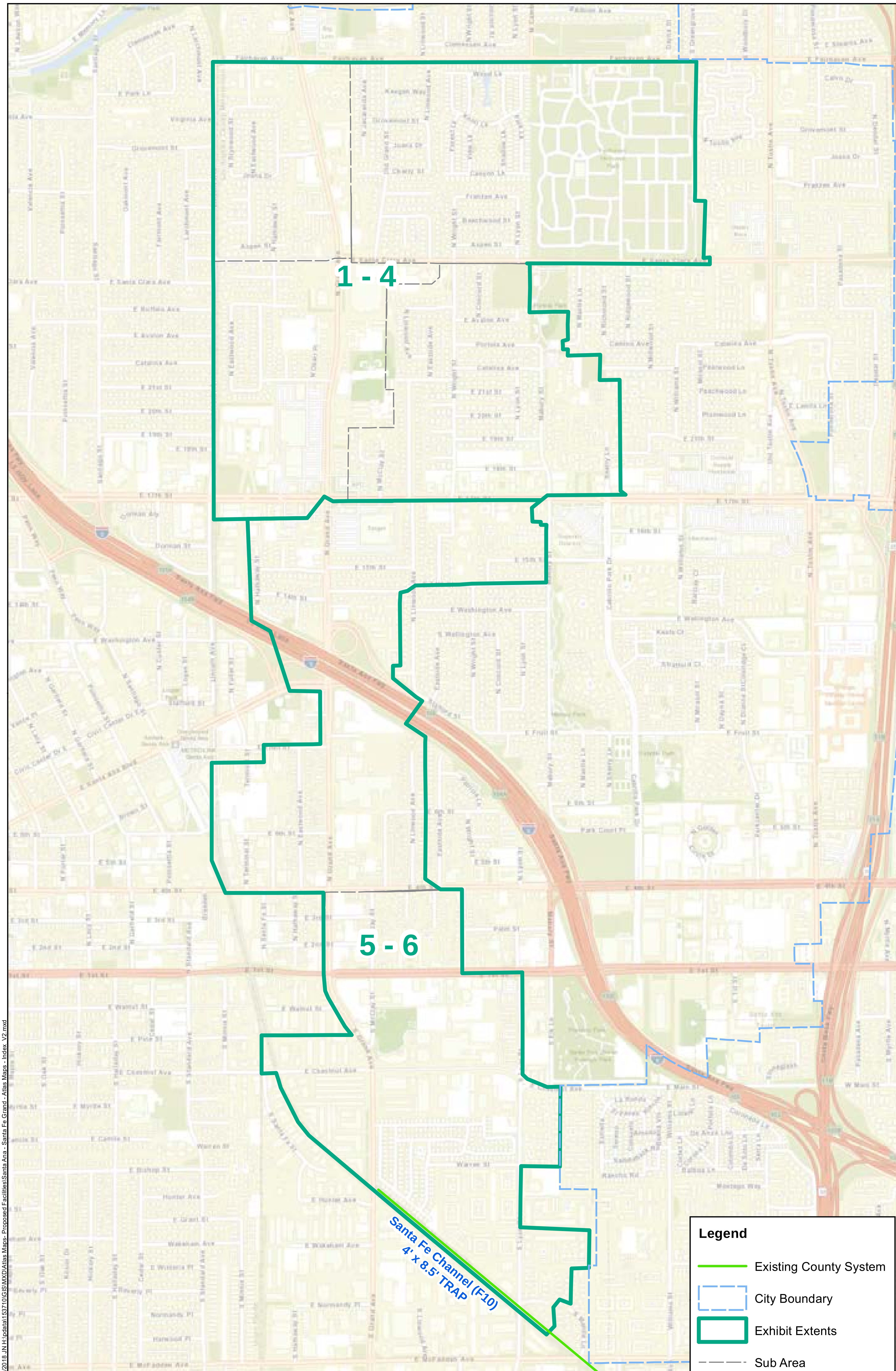
SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Grand Watershed - 100- year Difference Map

Figure 9-11



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Michael Baker INTERNATIONAL

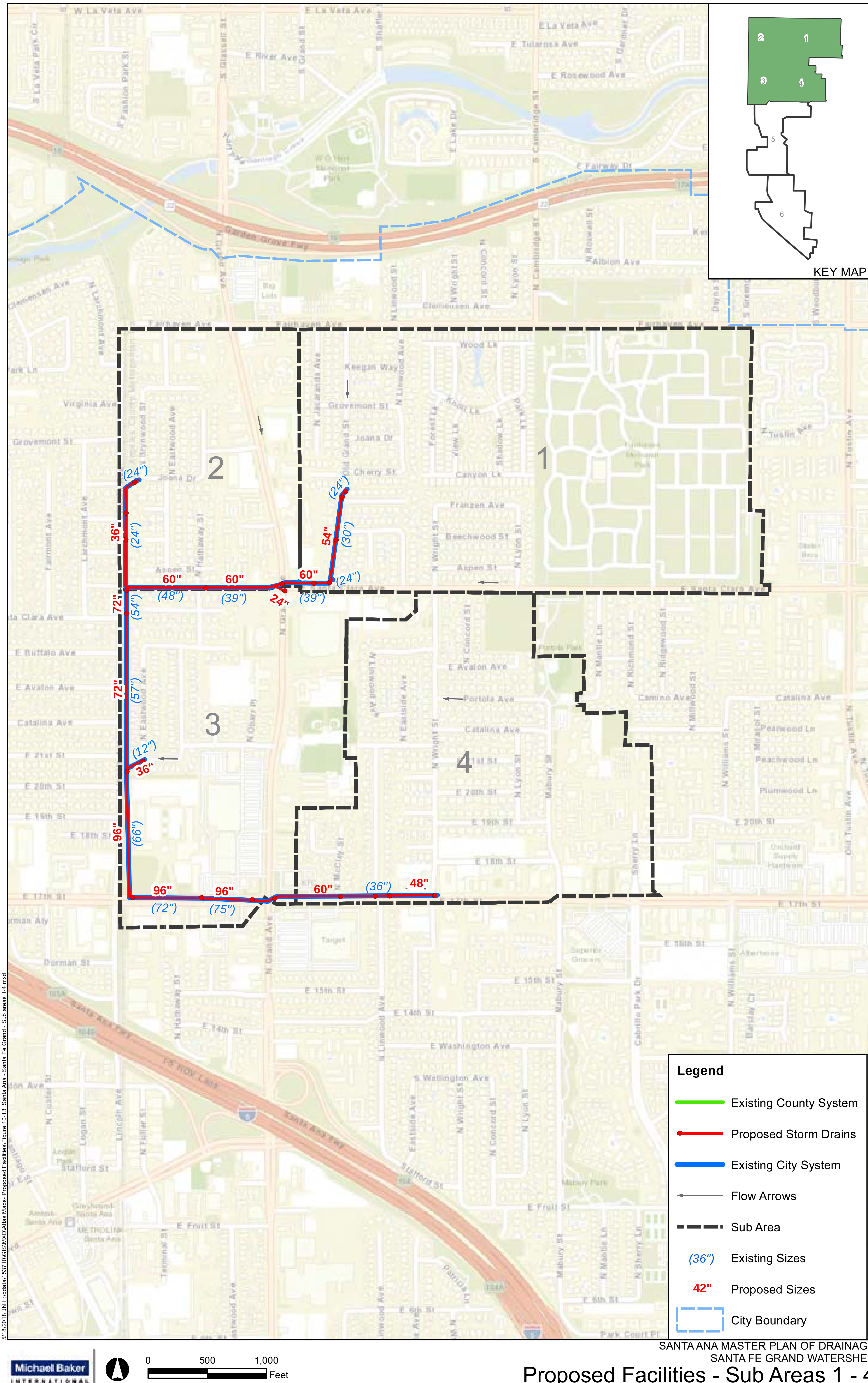
0 500 1,000 2,000 Feet

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA FE GRAND WATERSHED

Proposed Facilities - Exhibit Extents Index Map

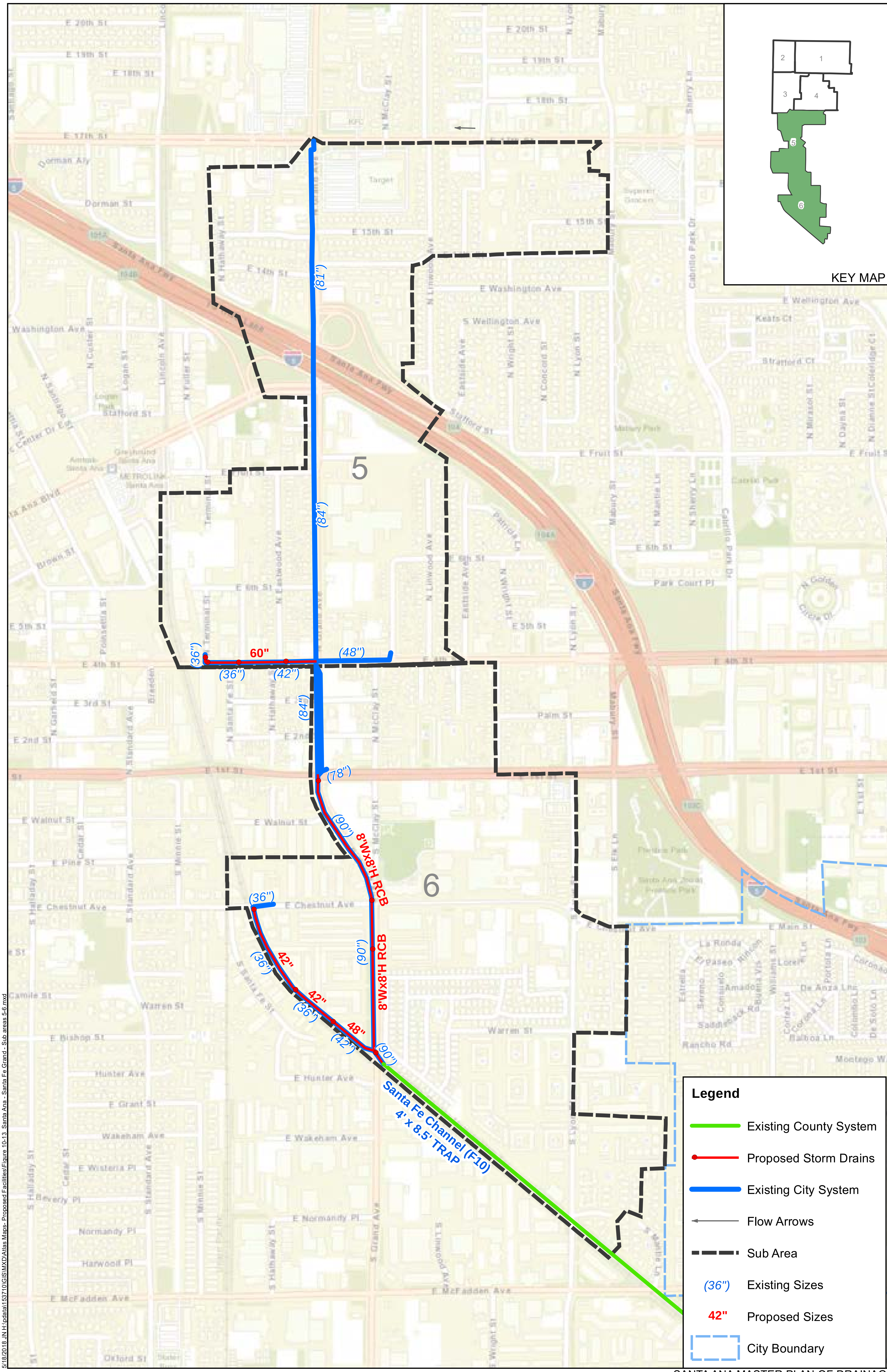
Figure 9-12



SANTA ANA MASTER PLAN OF DRAINAGE
SANTA FE GRAND WATERSHED

Proposed Facilities - Sub Areas 1 - 4

Figure 9-13



0 500 1,000 Feet

Source:

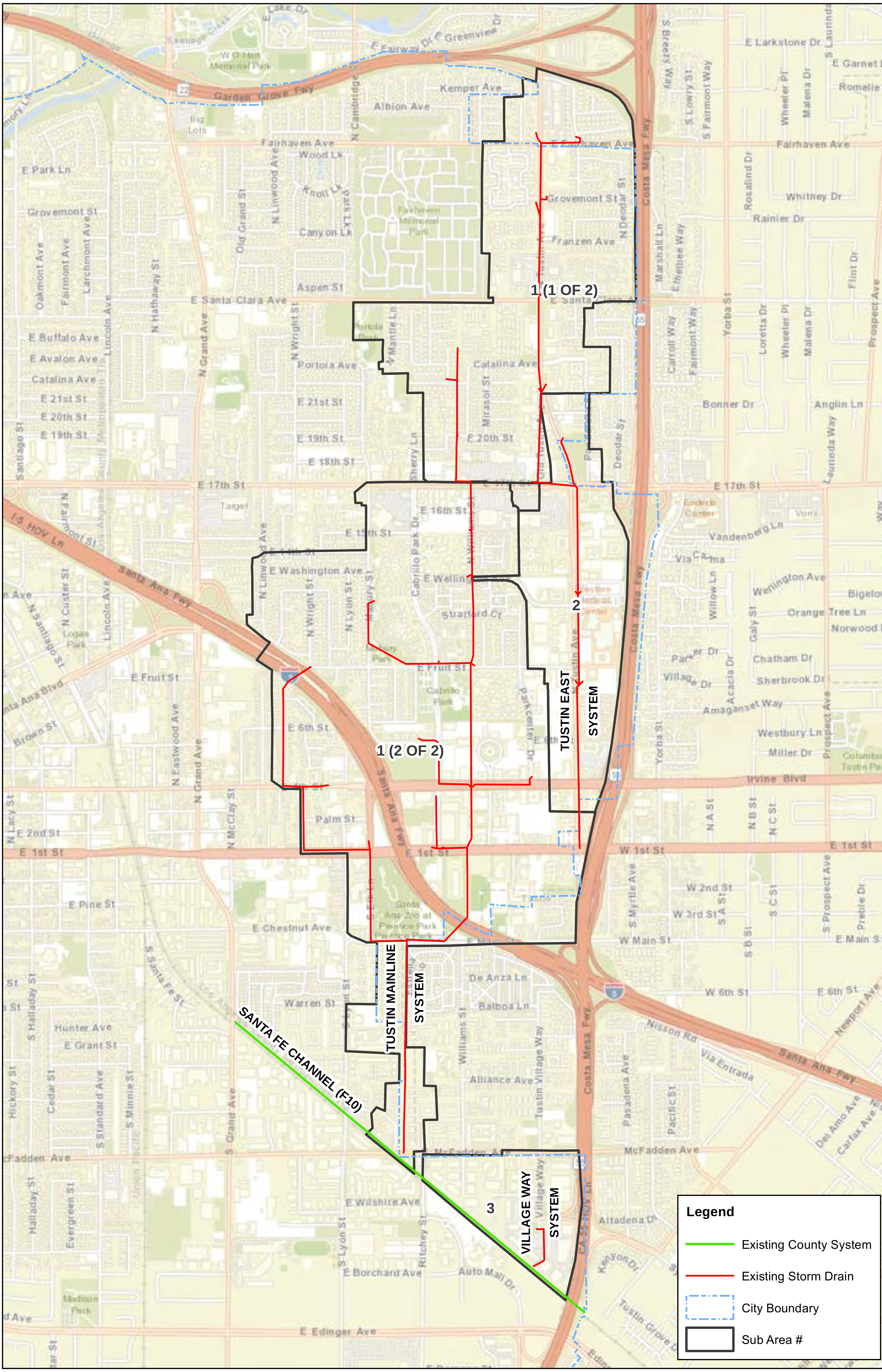
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA FE GRAND WATERSHED

Proposed Facilities - Sub Areas 5 - 6

Figure 10-14

SANTA FE TUSTIN EXHIBITS



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Michael Baker INTERNATIONAL

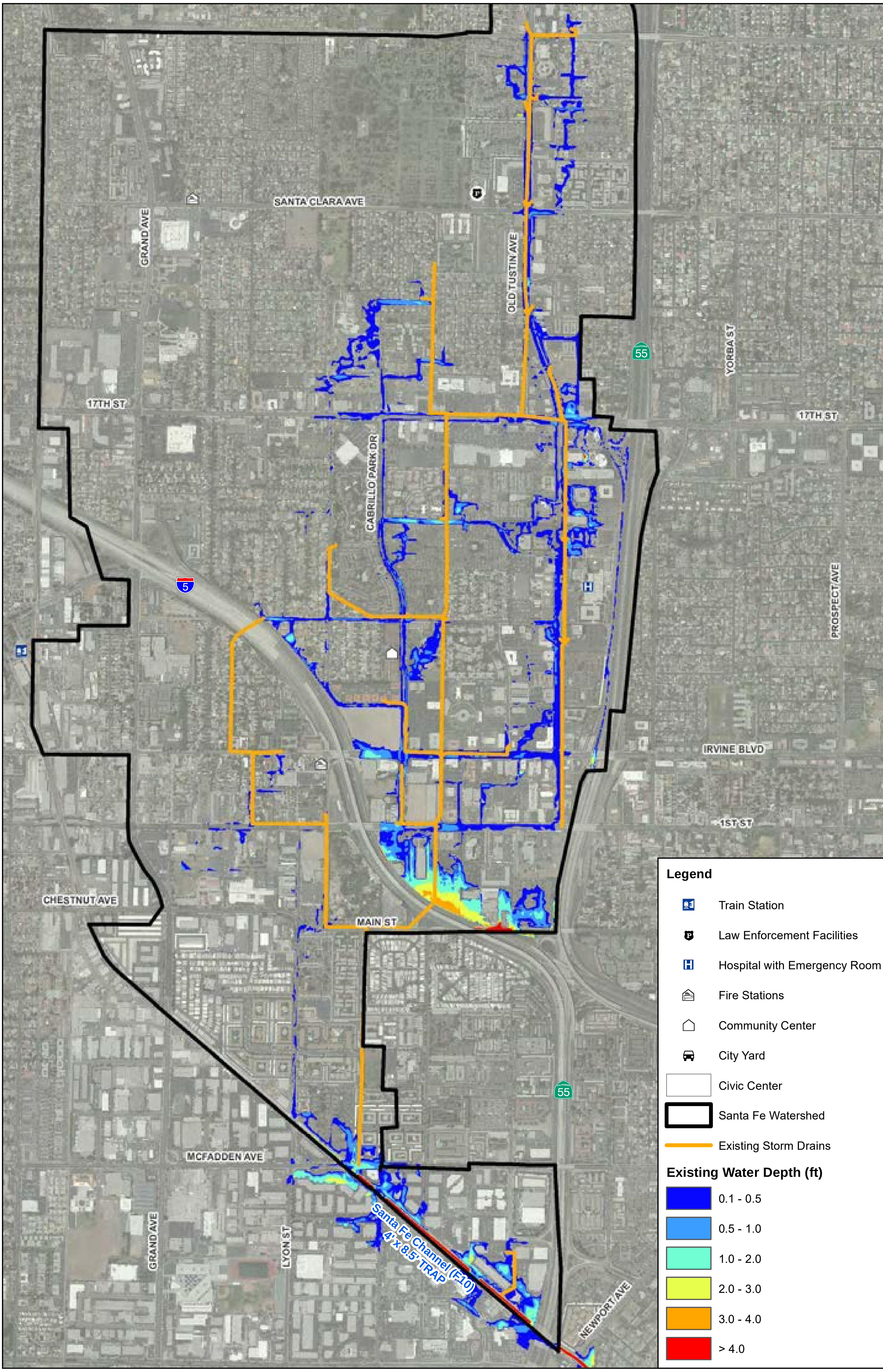
Source:

0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe-Tustin Watershed Sub Areas Exhibit

Figure 10-1



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Michael Baker INTERNATIONAL

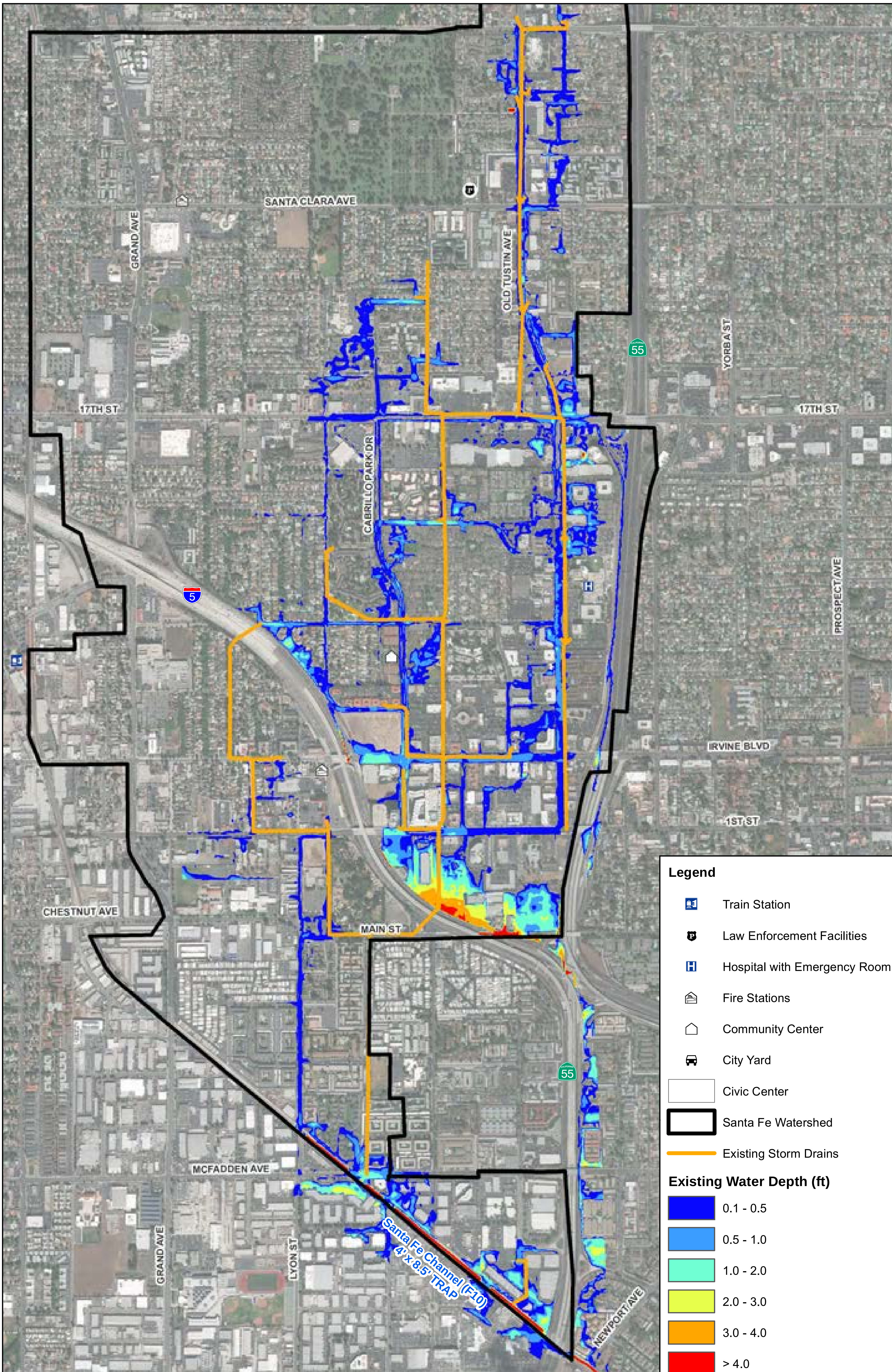
0 500 1,000 2,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - Maximum Flooded Depth Map

10- year Existing Condition

Figure 10-2



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Michael Baker INTERNATIONAL

0 500 1,000 2,000 Feet

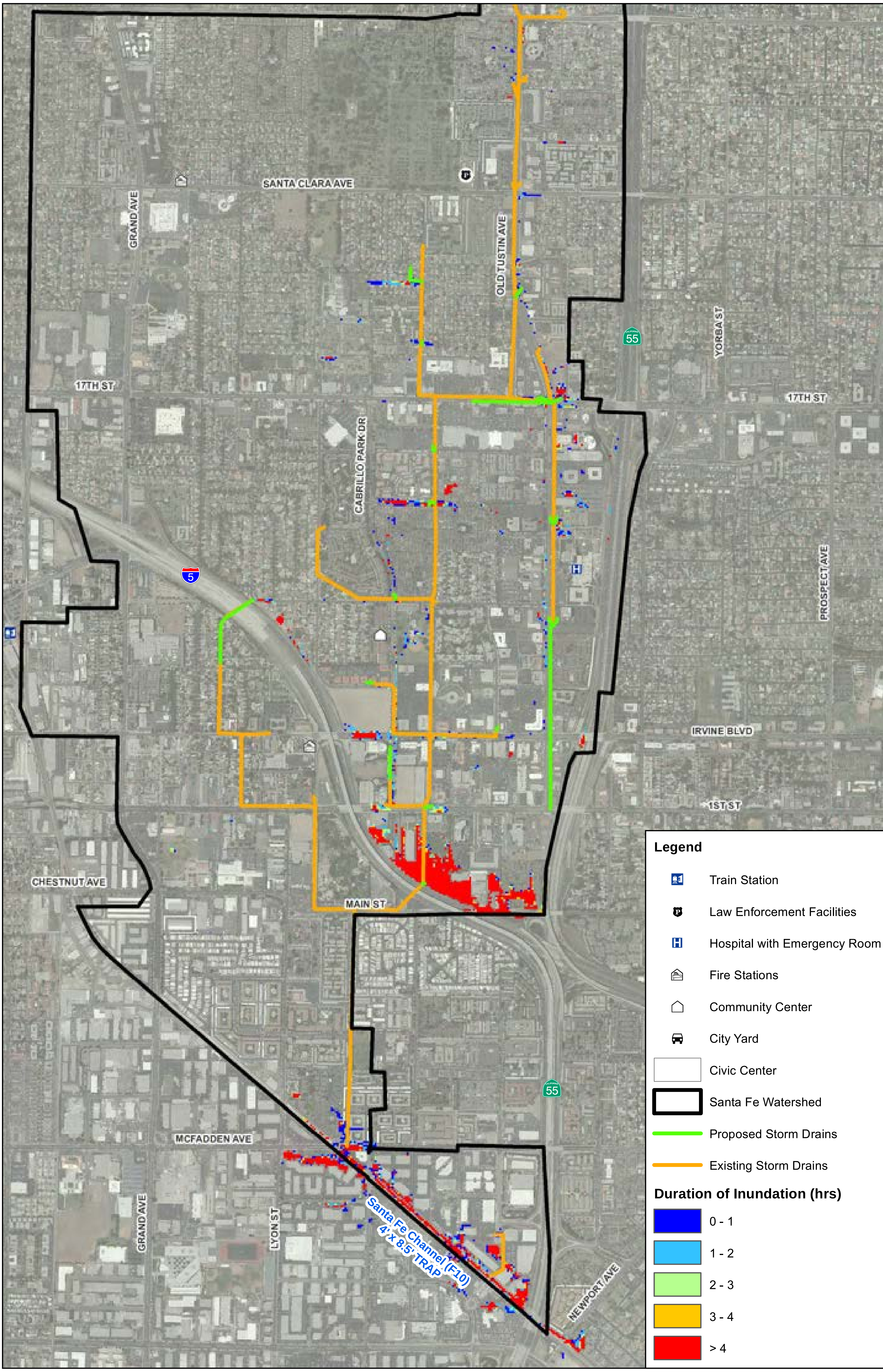
Source:

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - Maximum Flooded Depth Map

100- year Existing Condition

Figure 10-3



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Michael Baker INTERNATIONAL

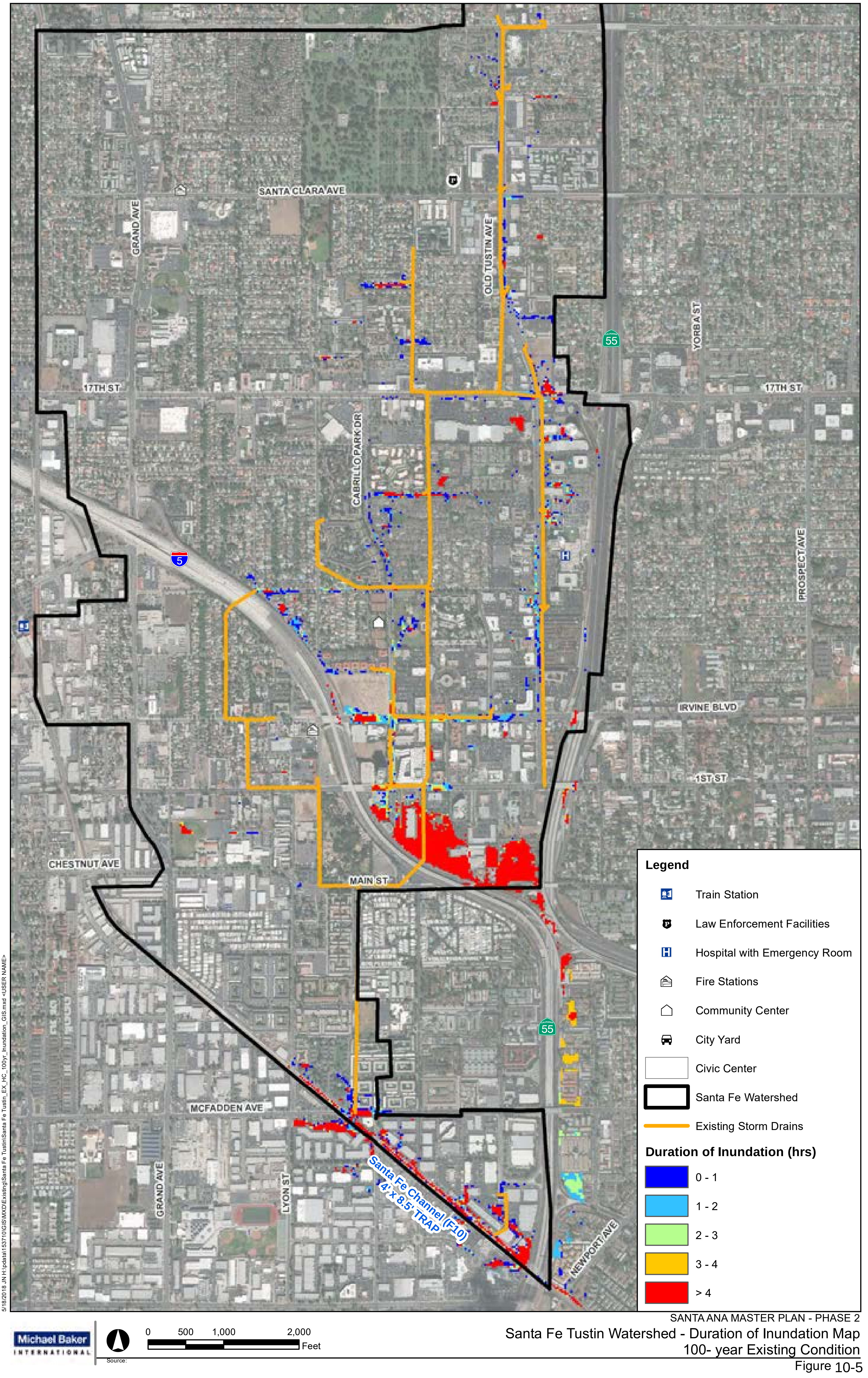
0 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - Duration of Inundation Map

10- year Existing Condition

Figure 10-4

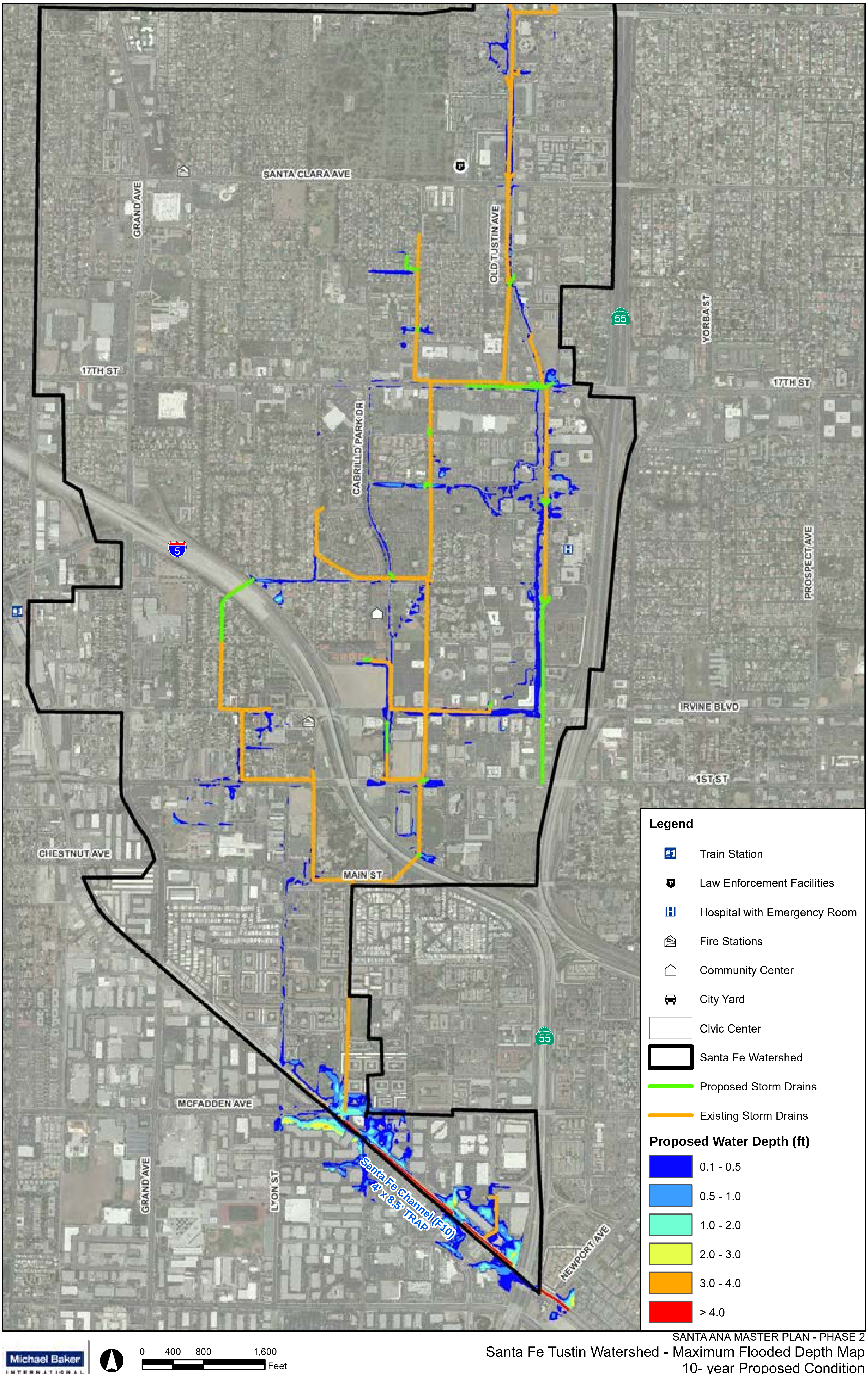


SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - Duration of Inundation Map

100- year Existing Condition

Figure 10-5



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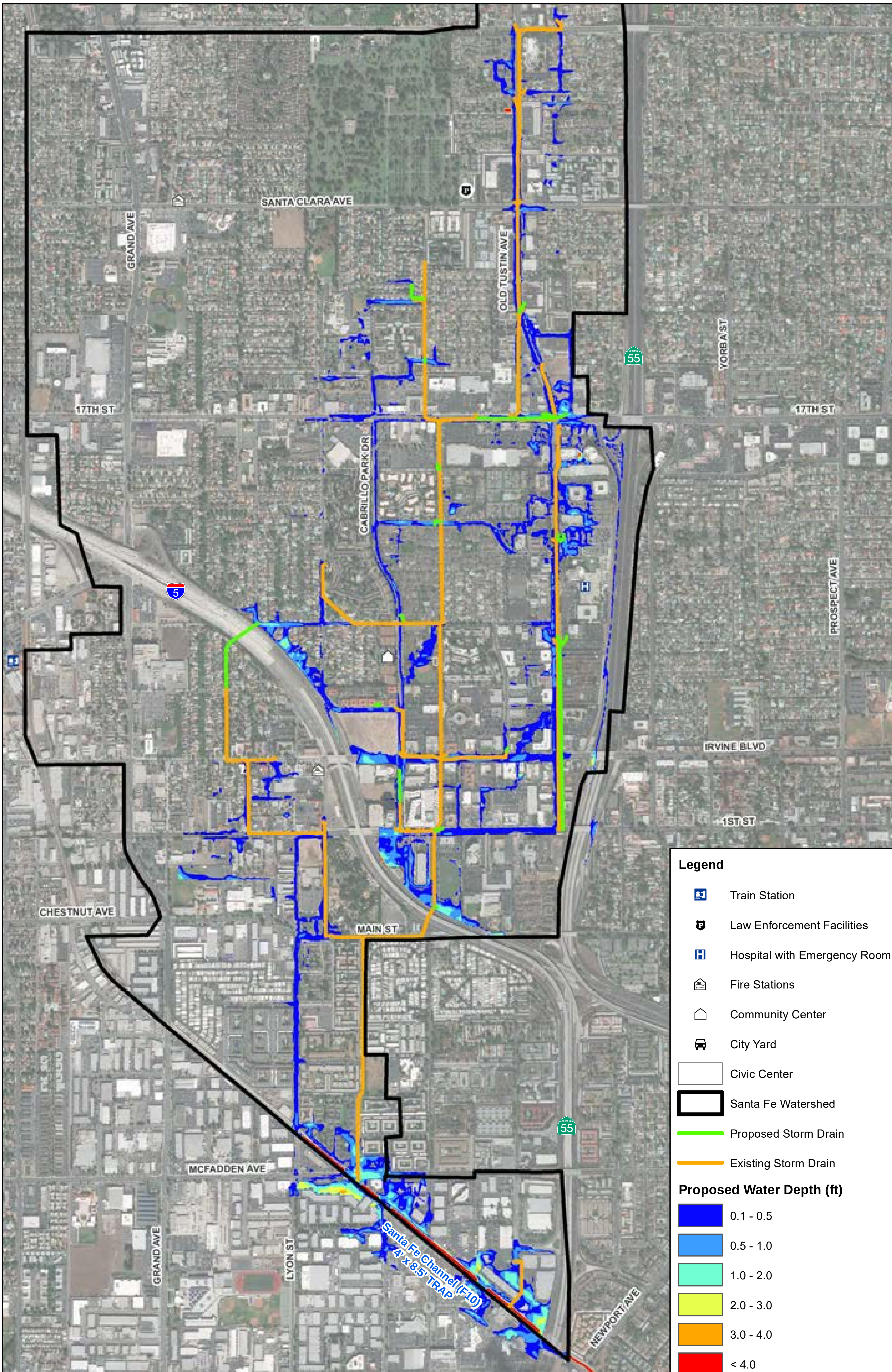
SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - Maximum Flooded Depth Map

10- year Proposed Condition

Figure 10-6



0 500 1,000 2,000 Feet

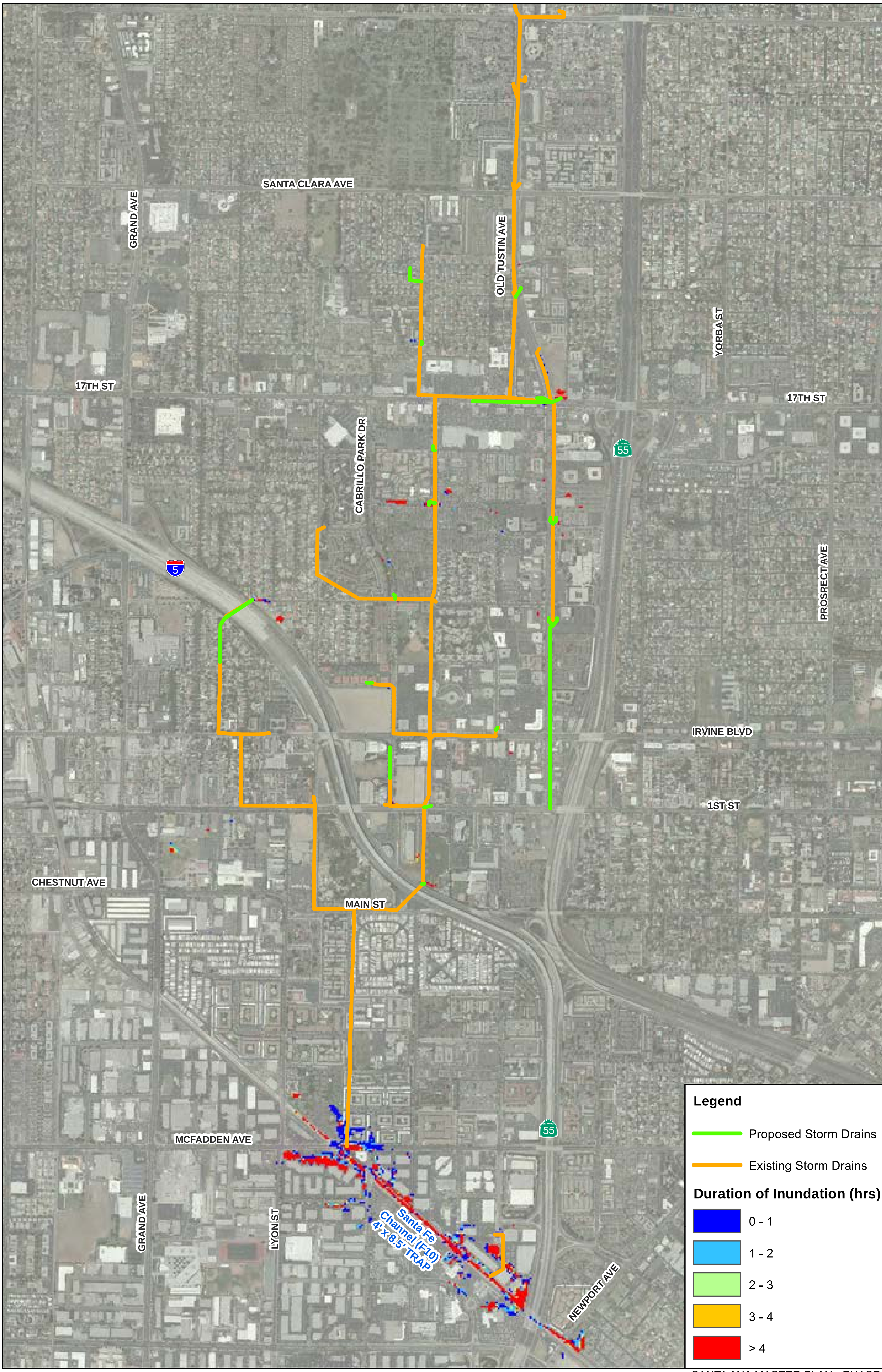
Source:

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - Maximum Flooded Depth Map

100- year Proposed Condition

Figure 10-7



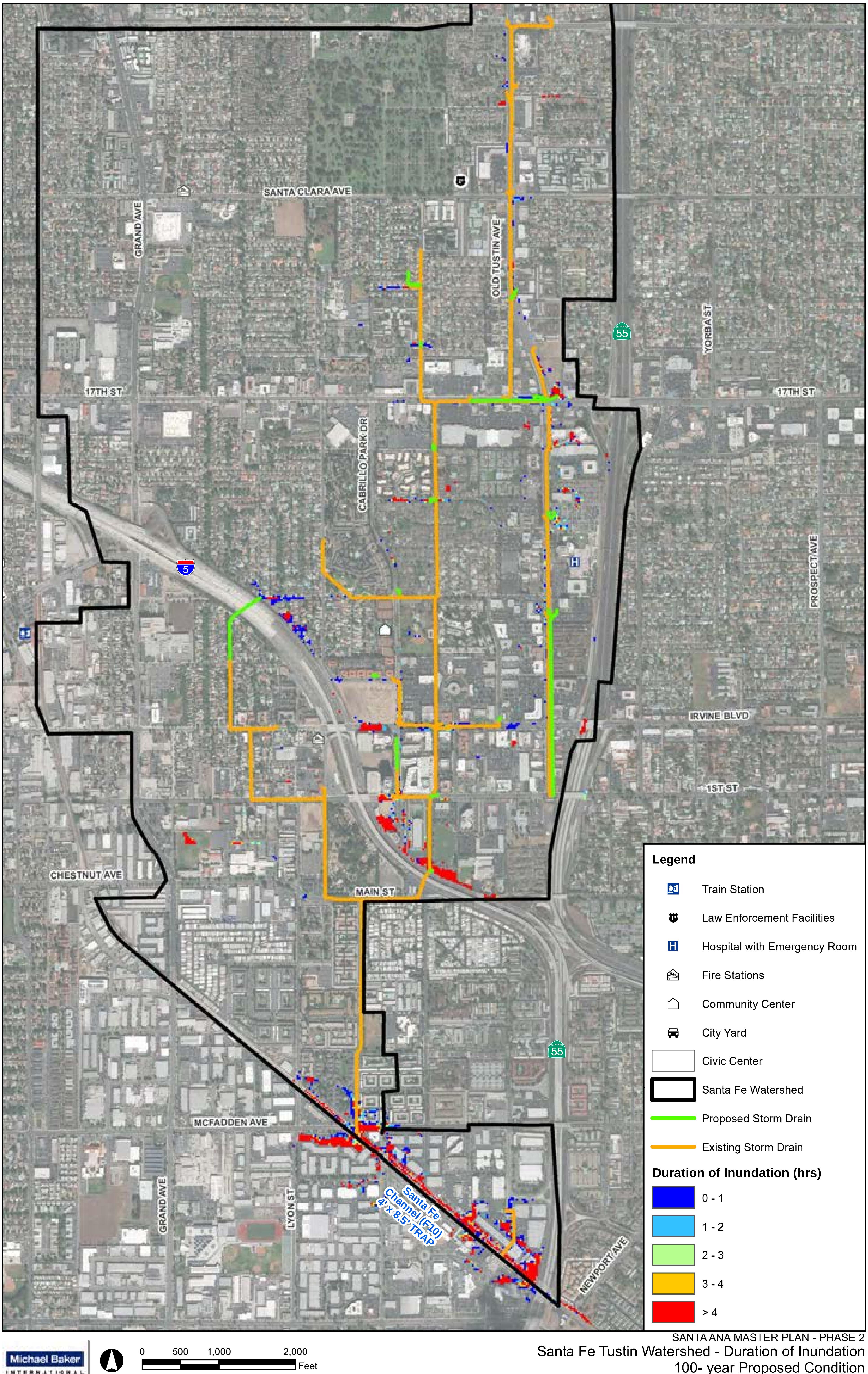
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - Duration of Inundation Map

10- year Proposed Condition

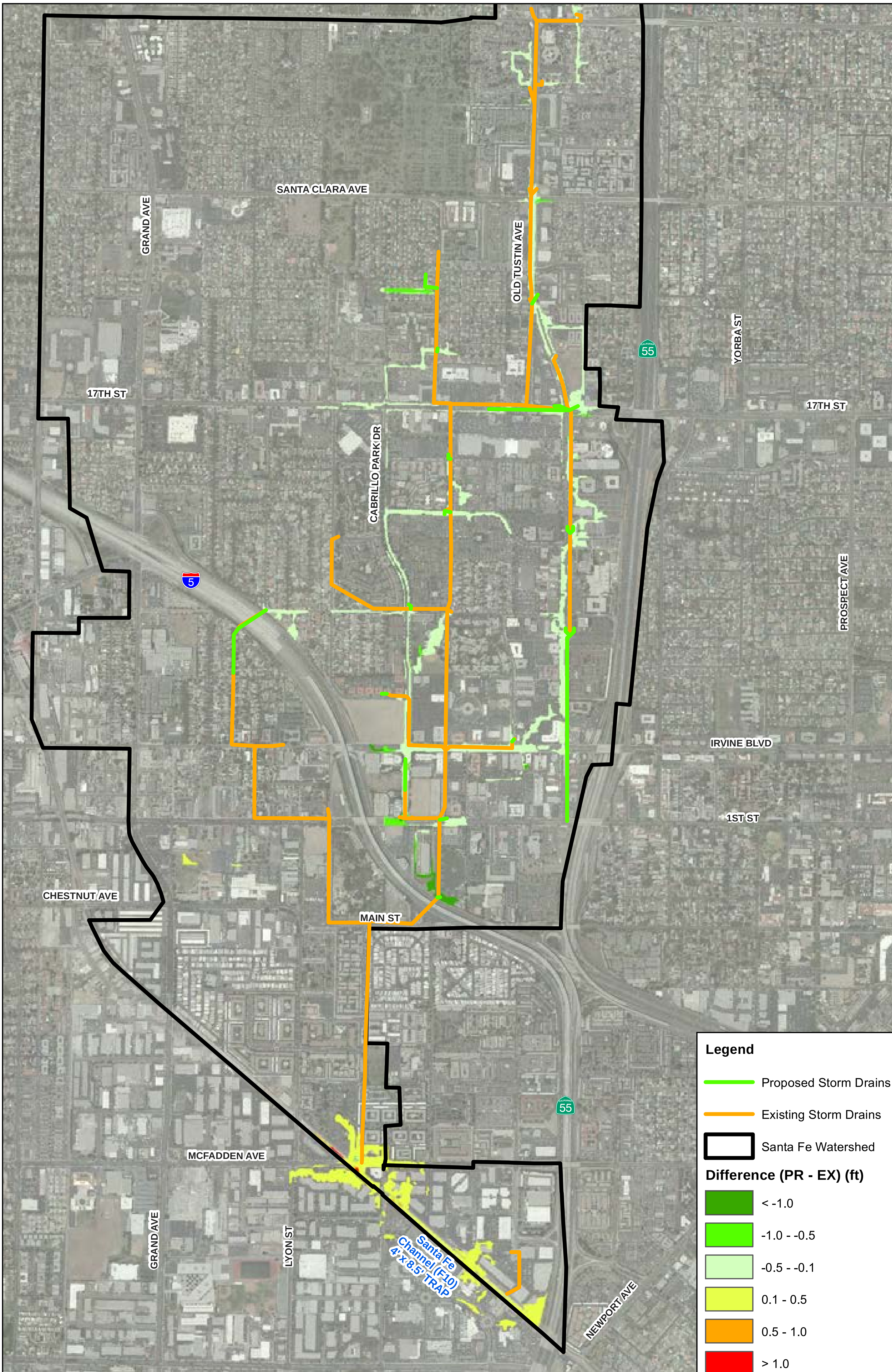
Figure 10-8



SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - Duration of Inundation
100- year Proposed Condition

Figure 10-9



Michael Baker INTERNATIONAL

Source:

0 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - 10-year Difference Map

Figure 10-10

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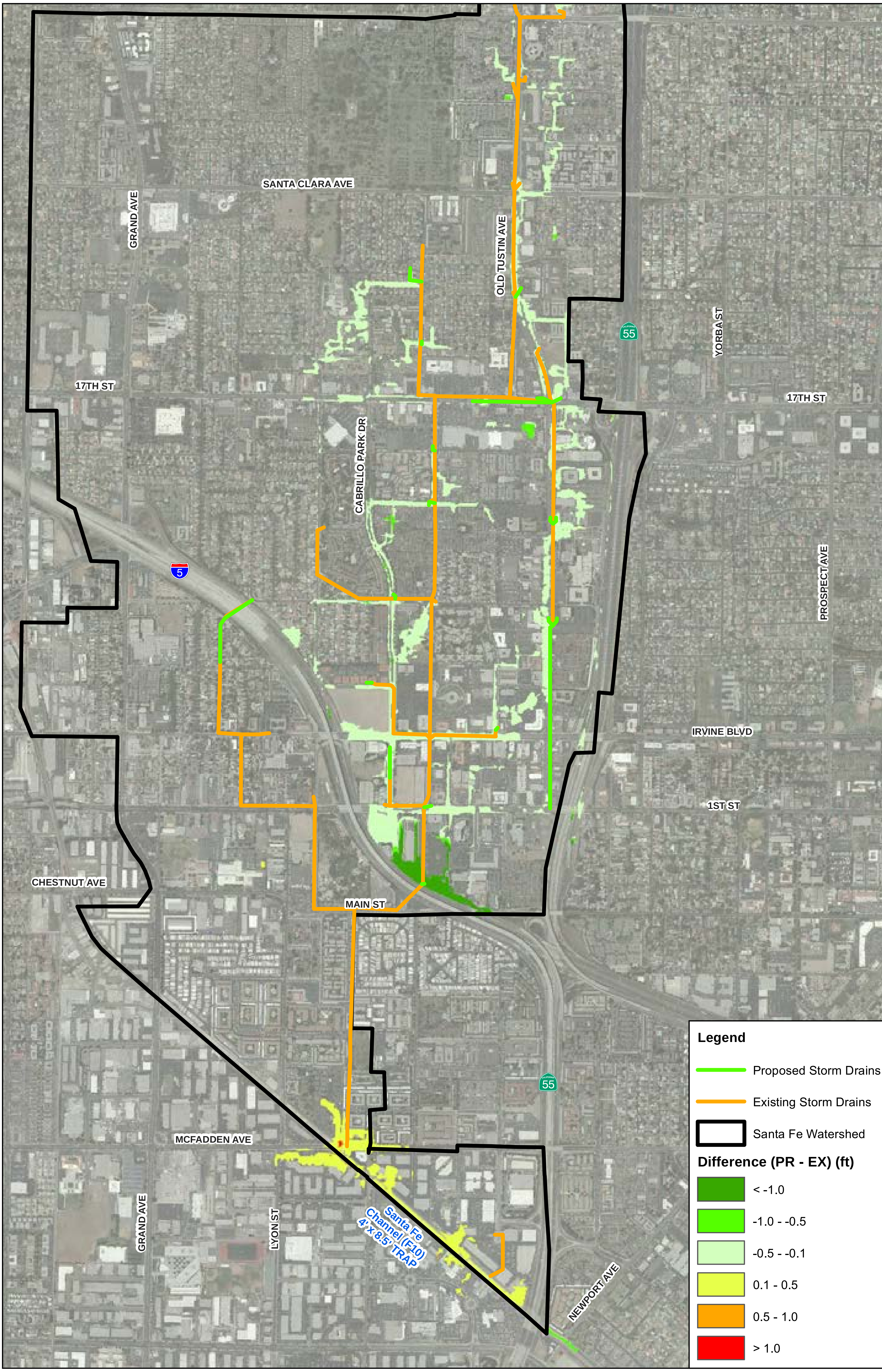

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Michael Baker INTERNATIONAL

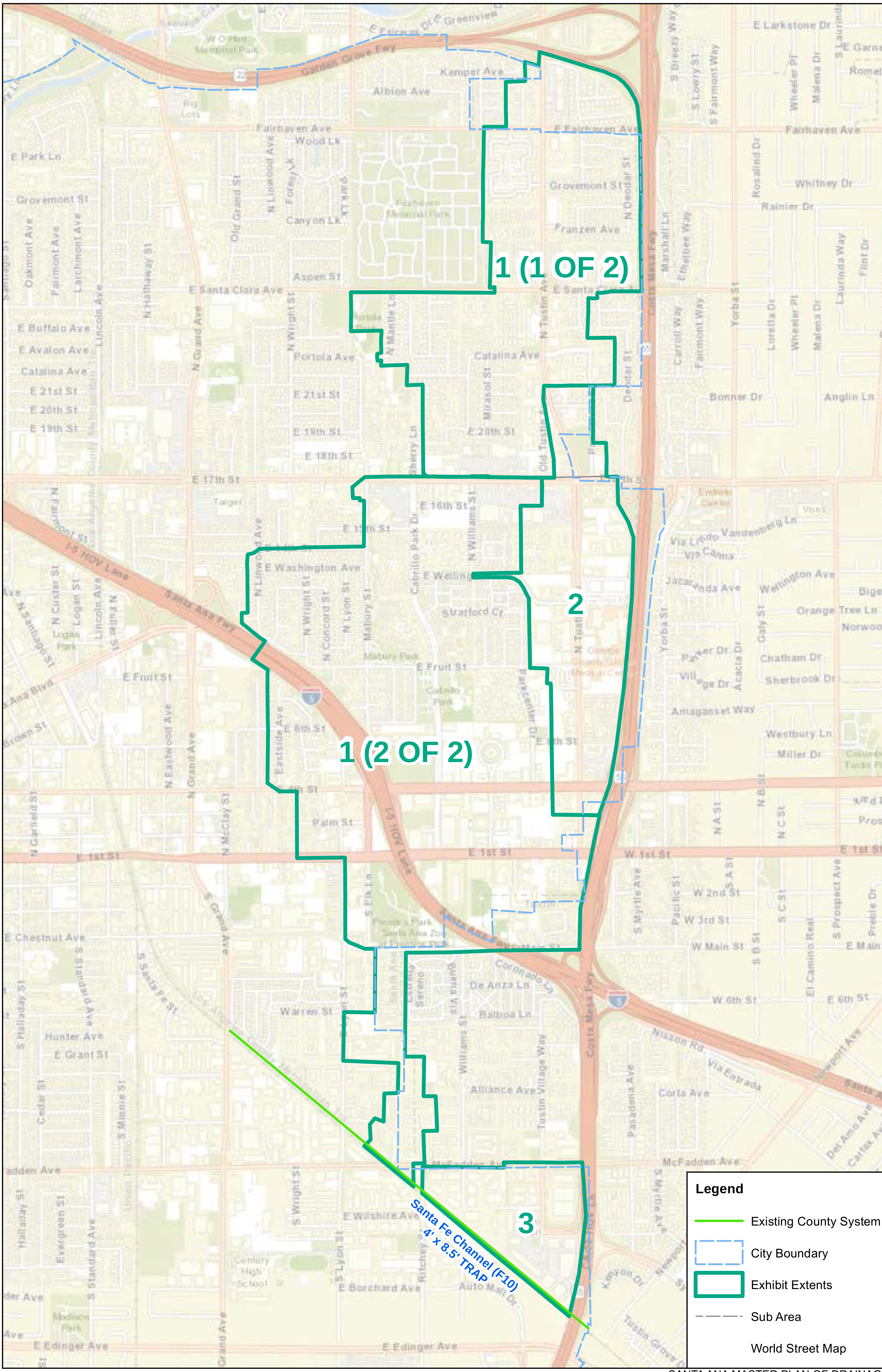
Source:

0 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Santa Fe Tustin Watershed - 100-year Difference Map

Figure 10-11



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Michael Baker INTERNATIONAL

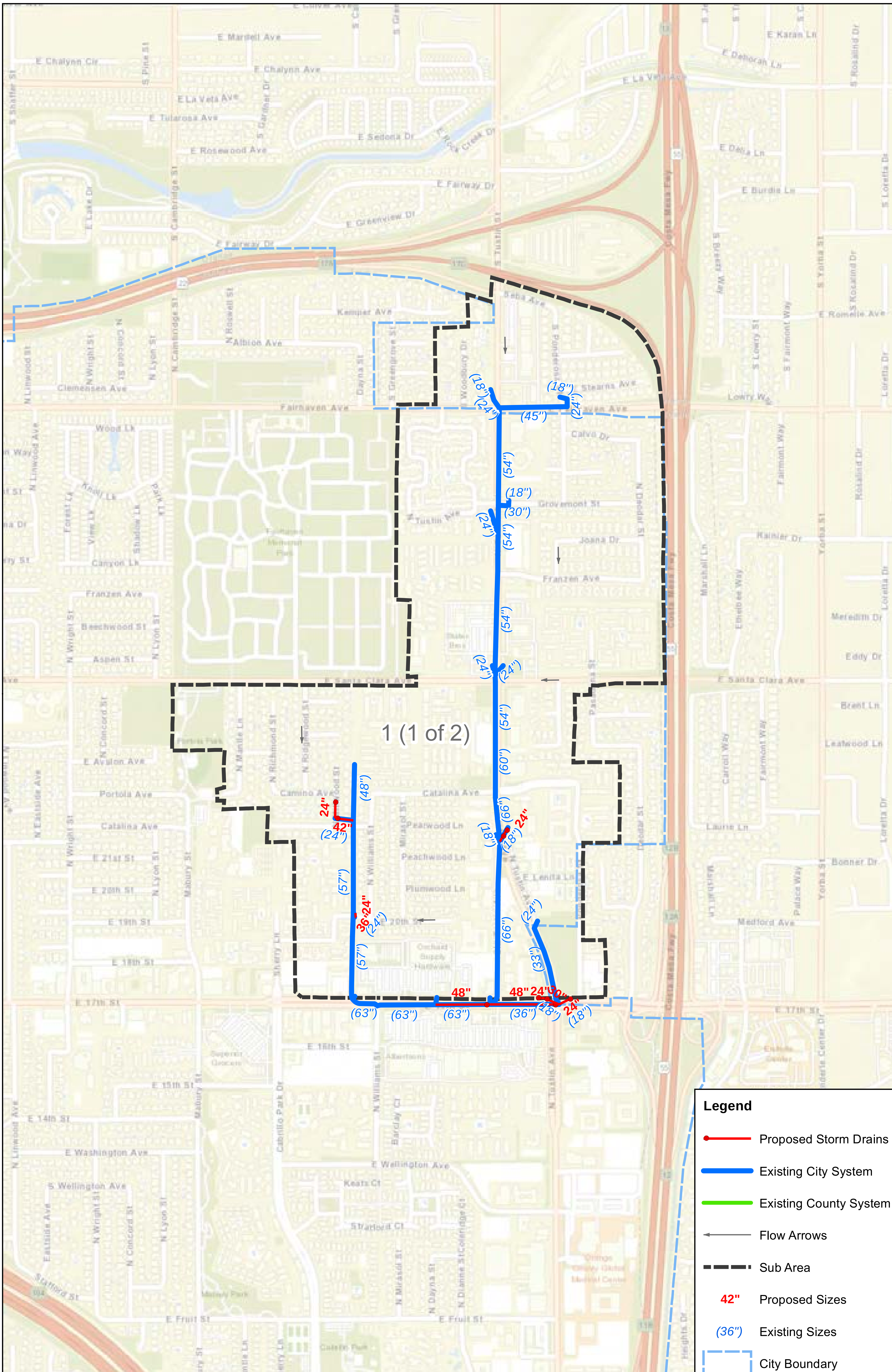
0 500 1,000 Feet

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA FE TUSTIN WATERSHED

Proposed Facilities - Exhibit Extents Index Map

Figure 10-12



0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA FE TUSTIN WATERSHED

Proposed Facilities - Sub Area 1 (1 of 2)

Figure 10-13

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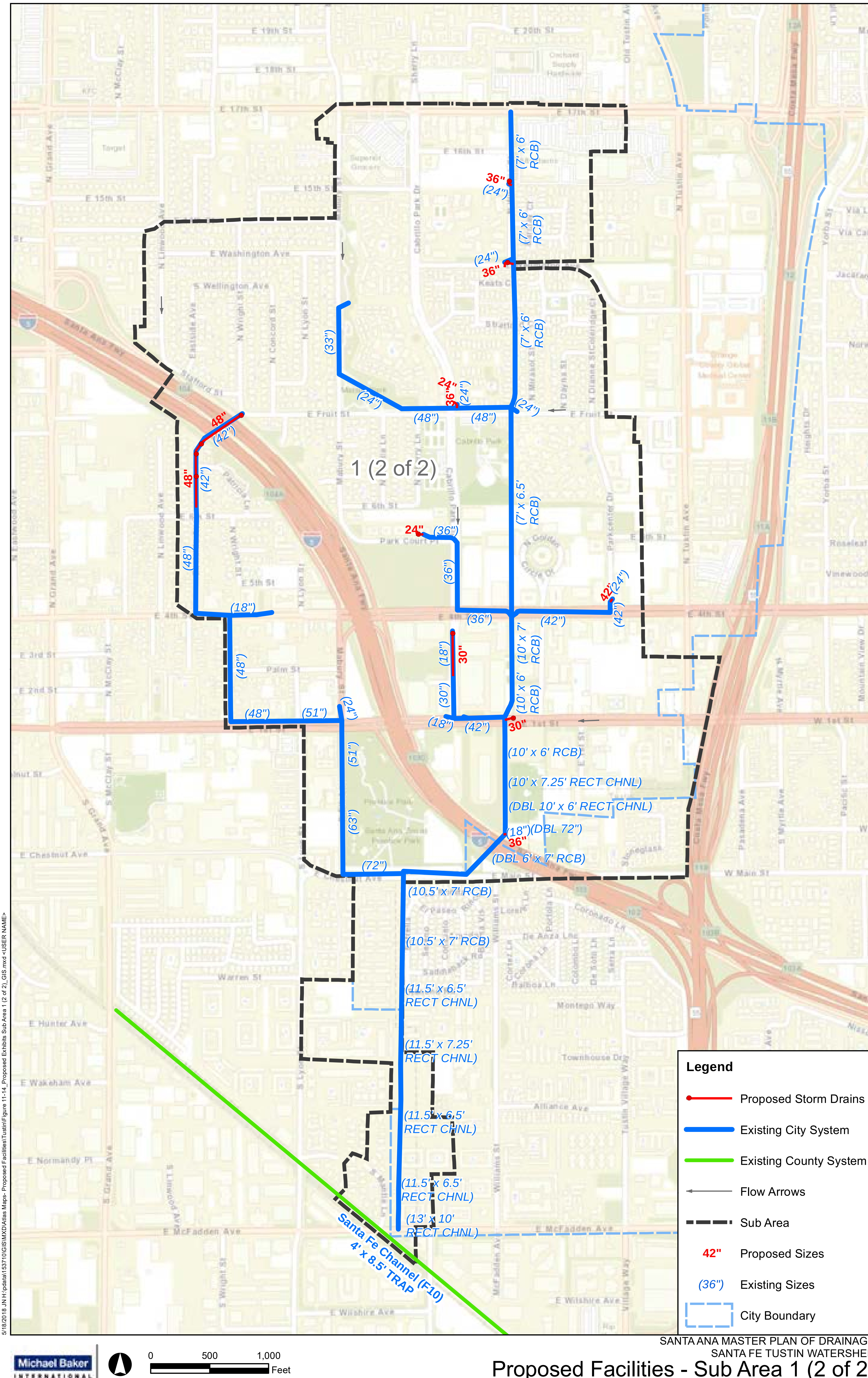
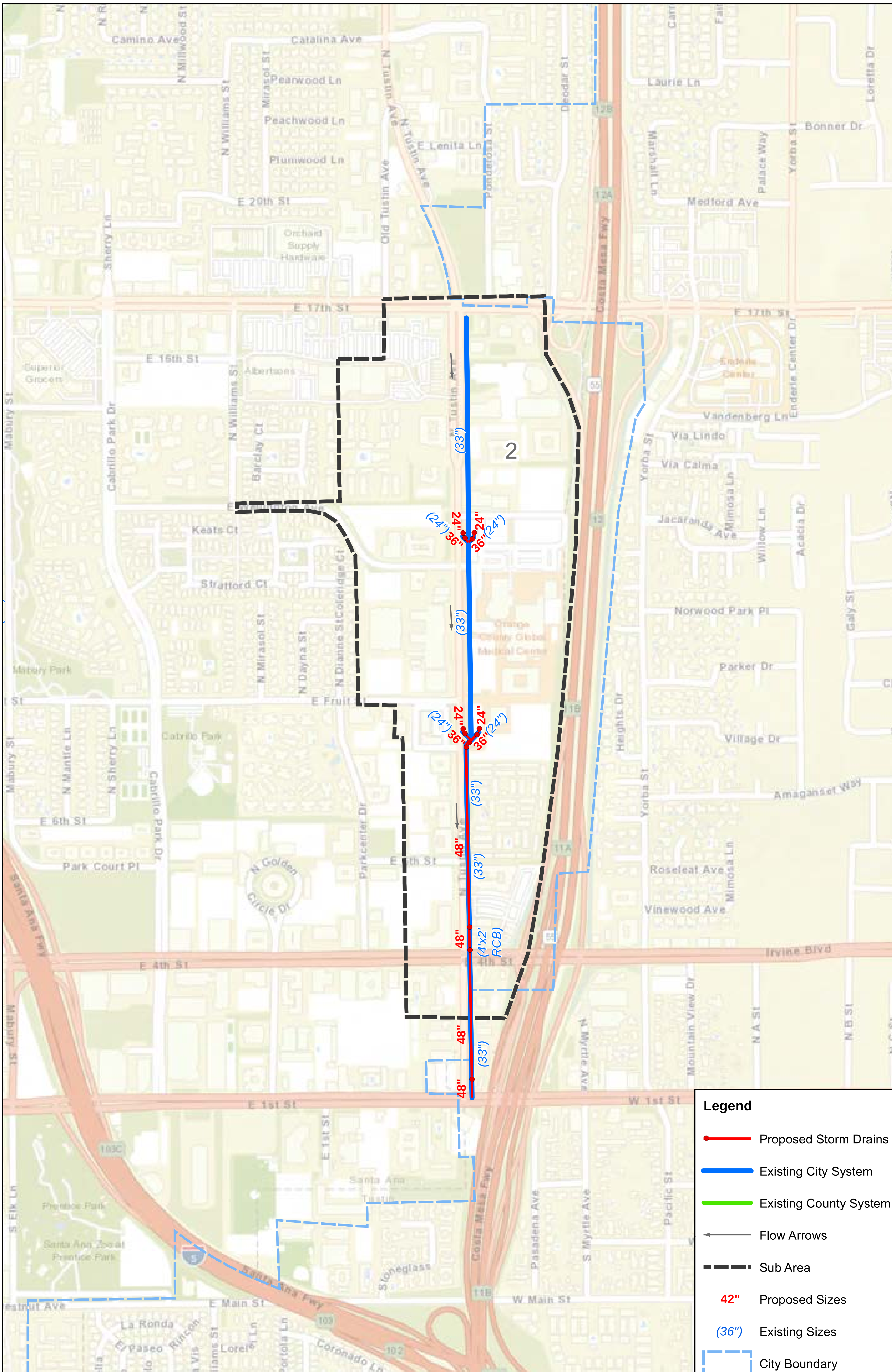


SANTA ANA MASTER PLAN OF DRAINAGE
SANTA FE TUSTIN WATERSHED

Proposed Facilities - Sub Area 1 (2 of 2)

Figure 10-14



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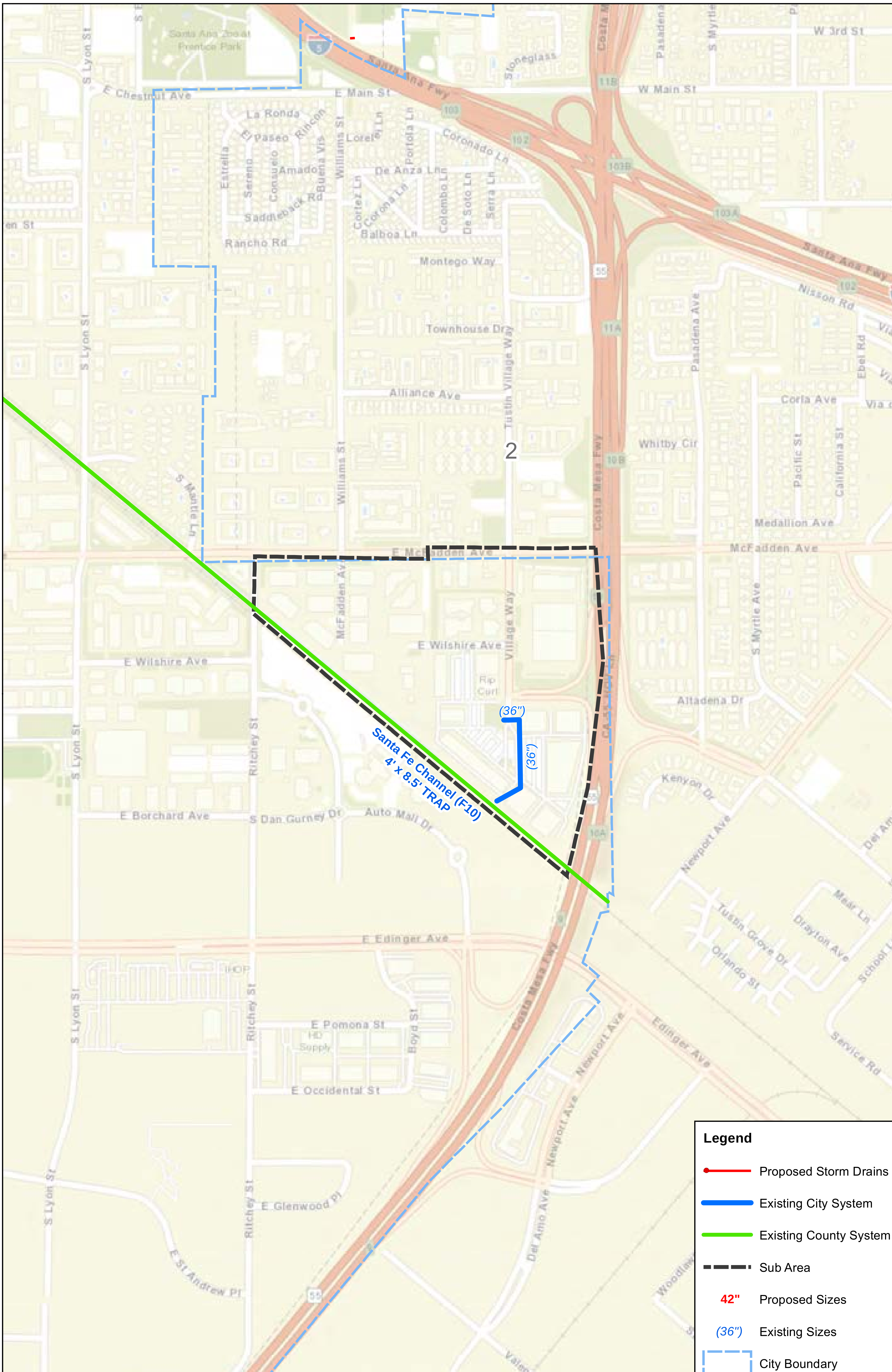
SANTA ANA MASTER PLAN OF DRAINAGE
SANTA FE TUSTIN WATERSHED

Proposed Facilities - Sub Area 2

Figure 10-15



0 500 1,000 Feet

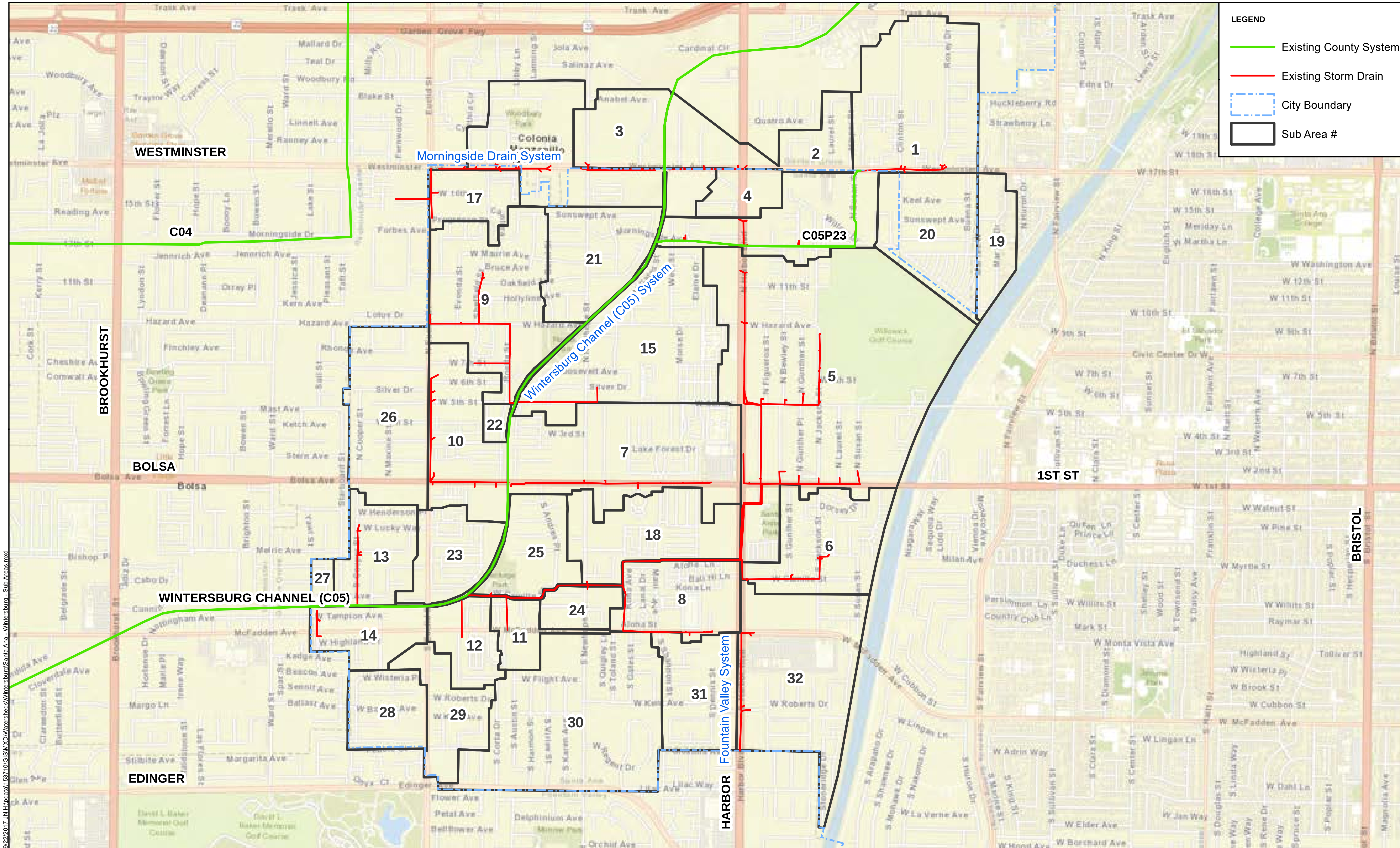
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN OF DRAINAGE
SANTA FE TUSTIN WATERSHED

Proposed Facilities - Sub Area 3

Figure 10-16

WINTERSBURG EXHIBITS



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0 1,000 2,000 Feet

Michael Baker INTERNATIONAL

Source: Streets Basemapl - Esri

SANTA ANA MASTER PLAN OF DRAINAGE
WINTERSBURG WATERSHED

Watershed Subarea Map

FIGURE 11-1

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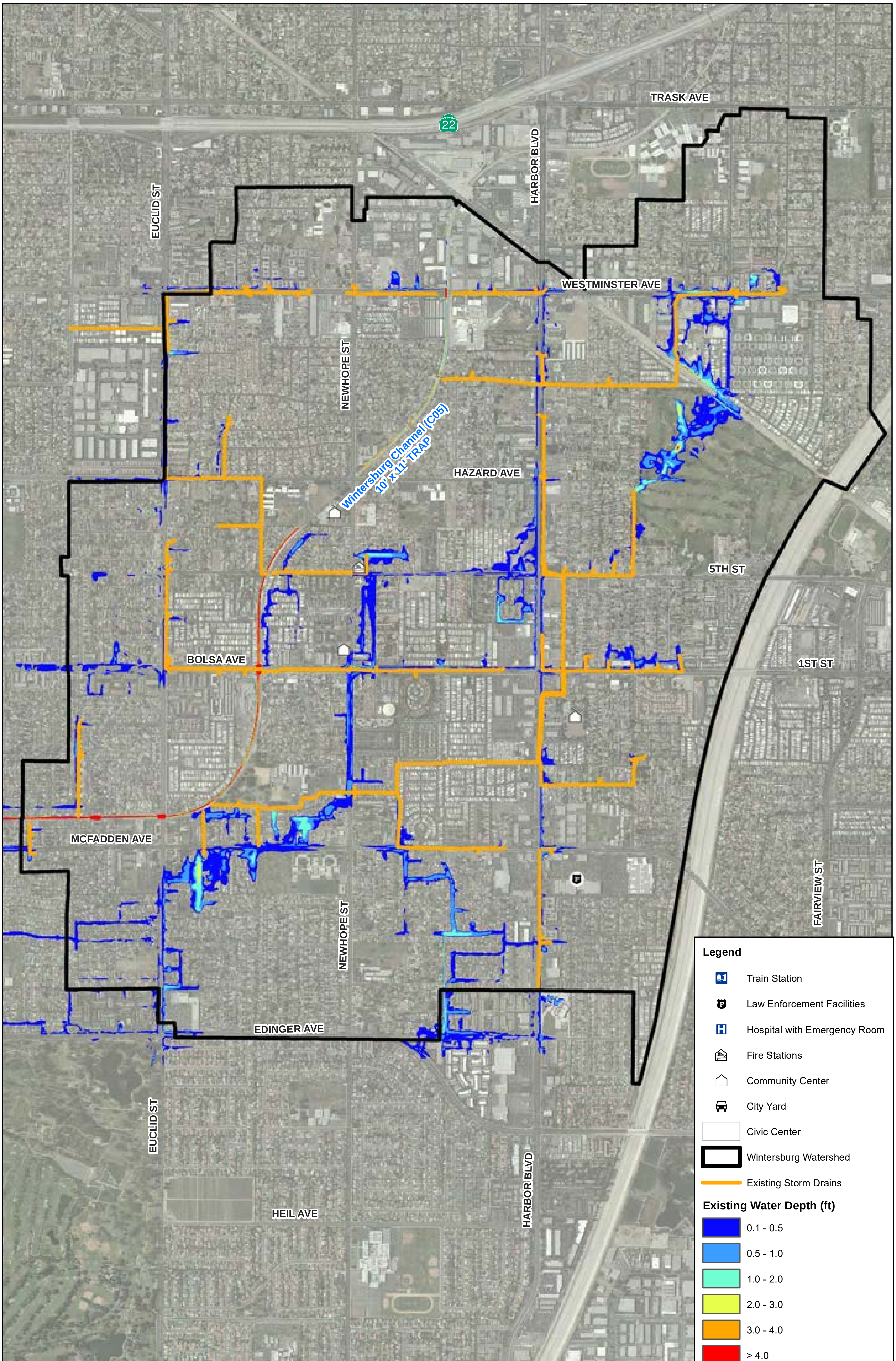

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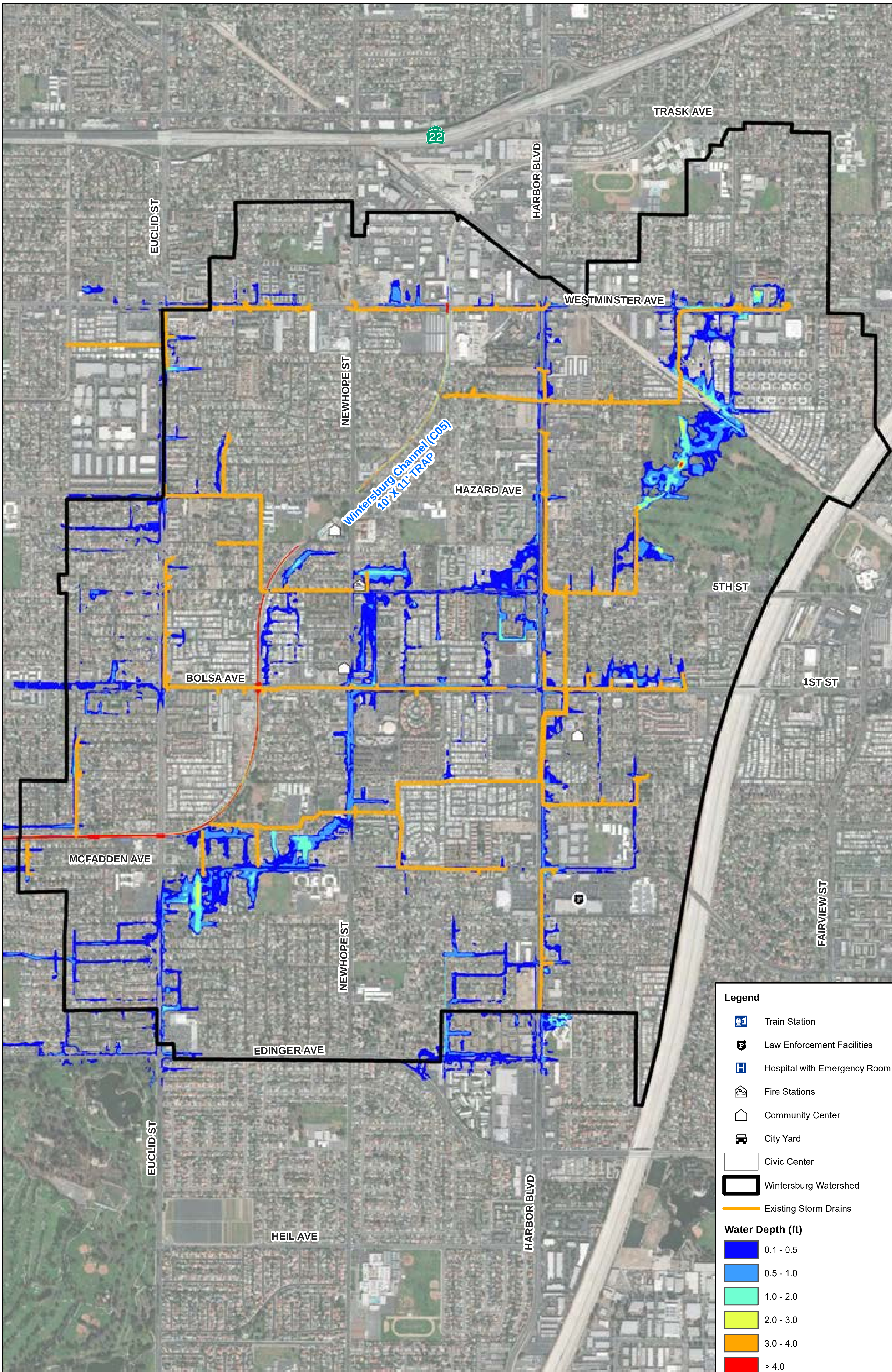
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - Maximum Flooded Depth Map

10- year Existing Condition

Figure 11-2



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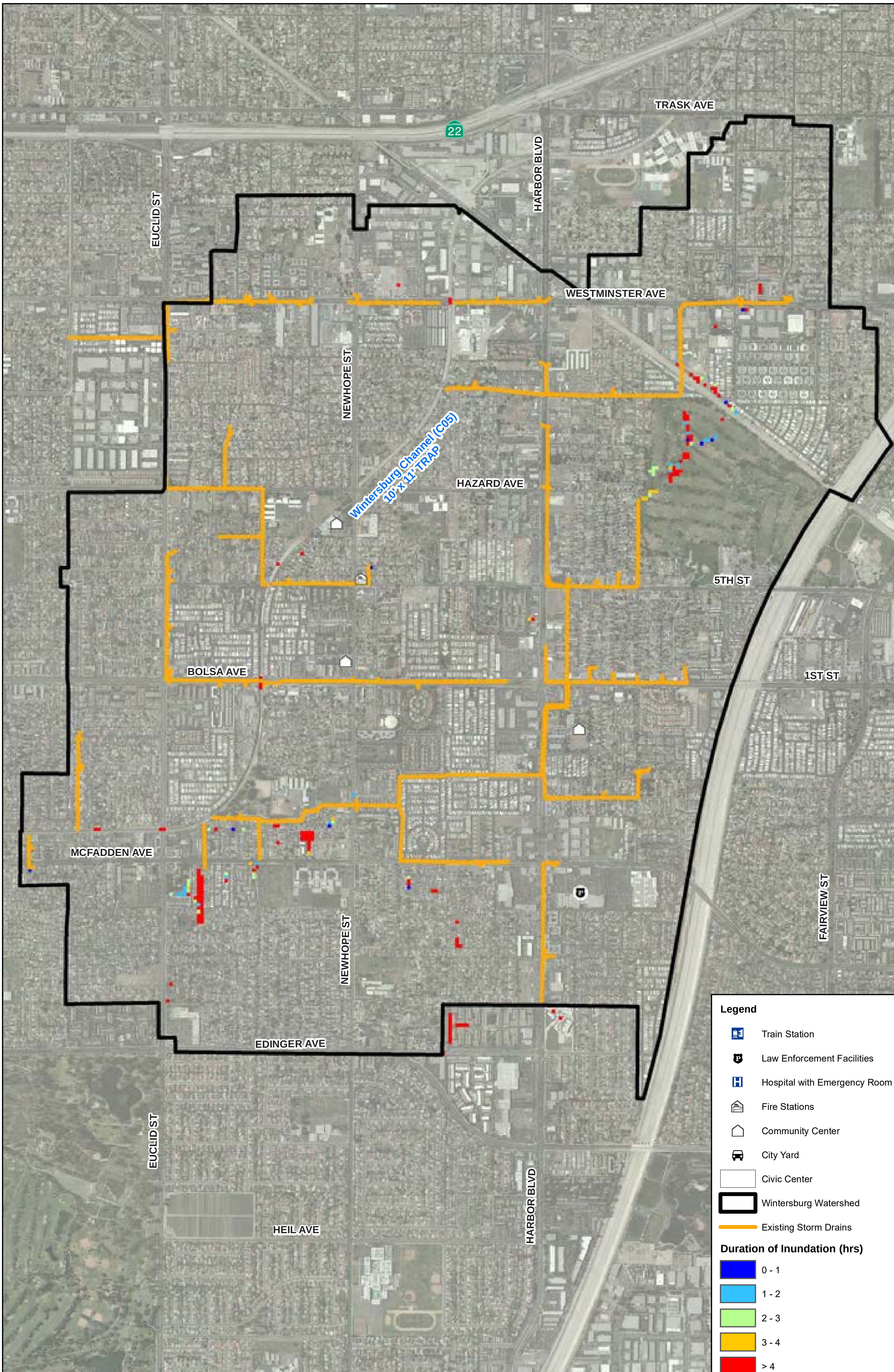
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - Maximum Flooded Depth Map

100- year Existing Condition

Figure 11-3



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Michael Baker INTERNATIONAL

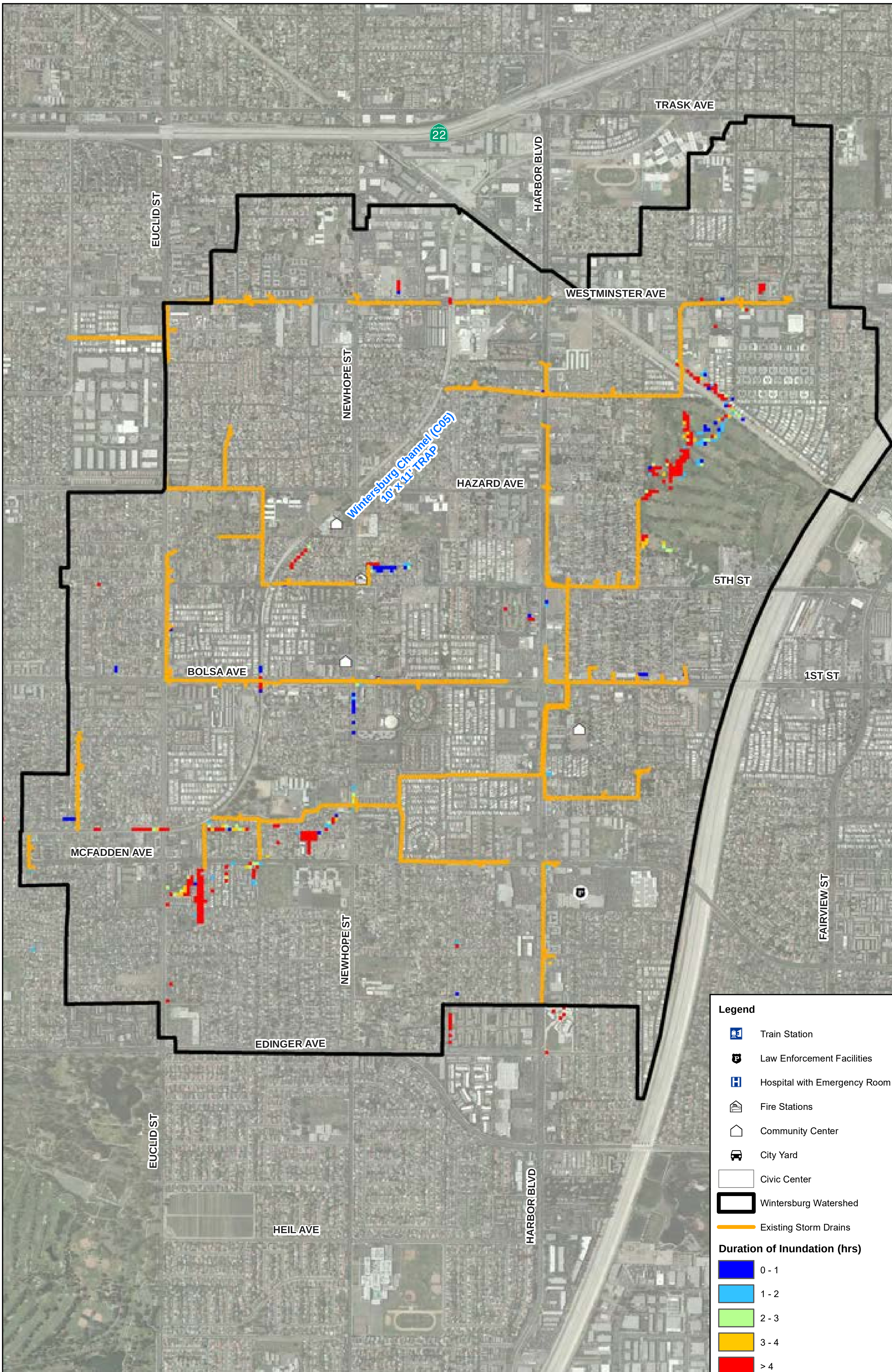
0 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - Duration of Inundation

10- year Existing Condition

Figure 11-4



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Michael Baker INTERNATIONAL

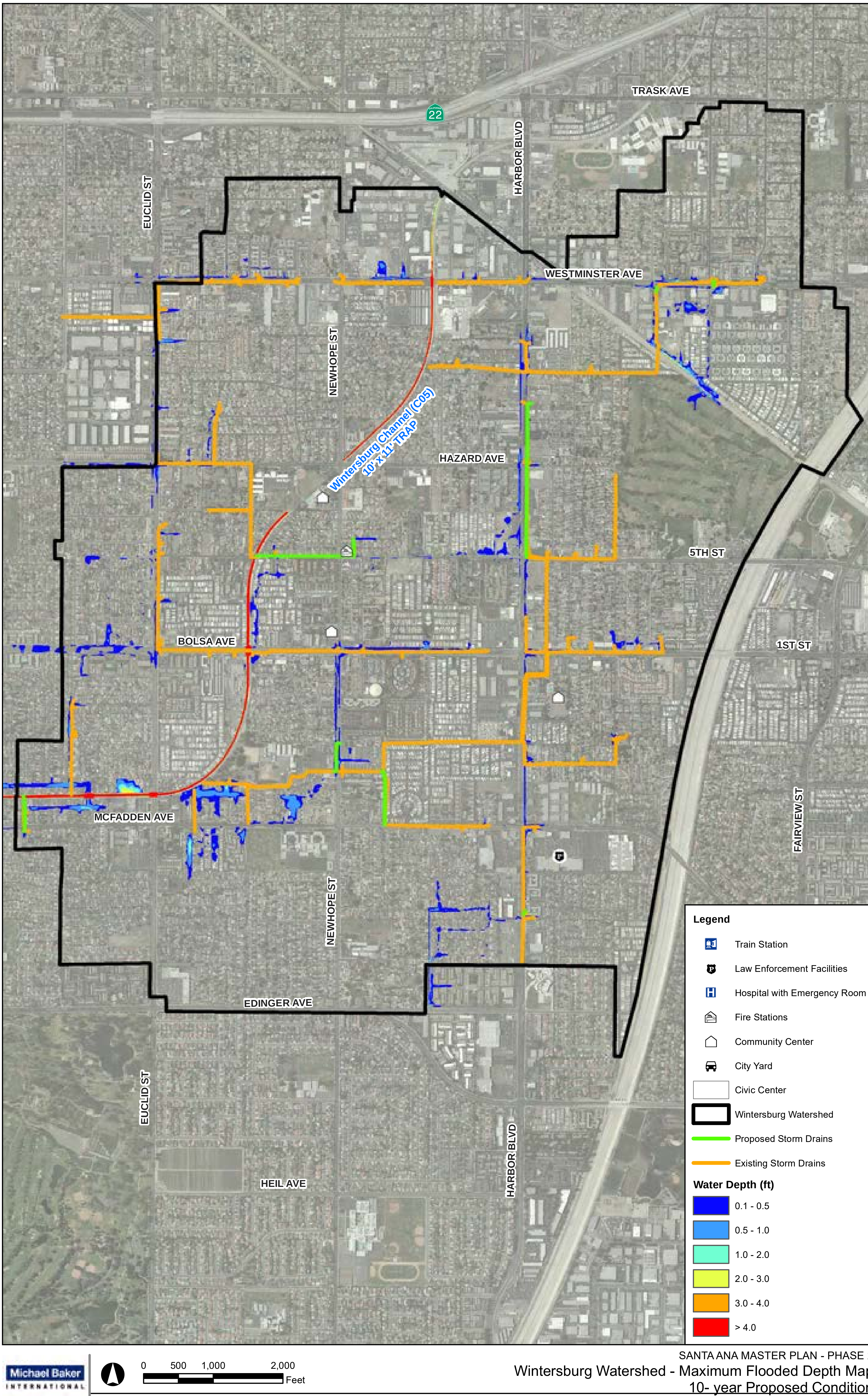
0 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - Duration of Inundation

100- year Existing Condition

Figure 11-5



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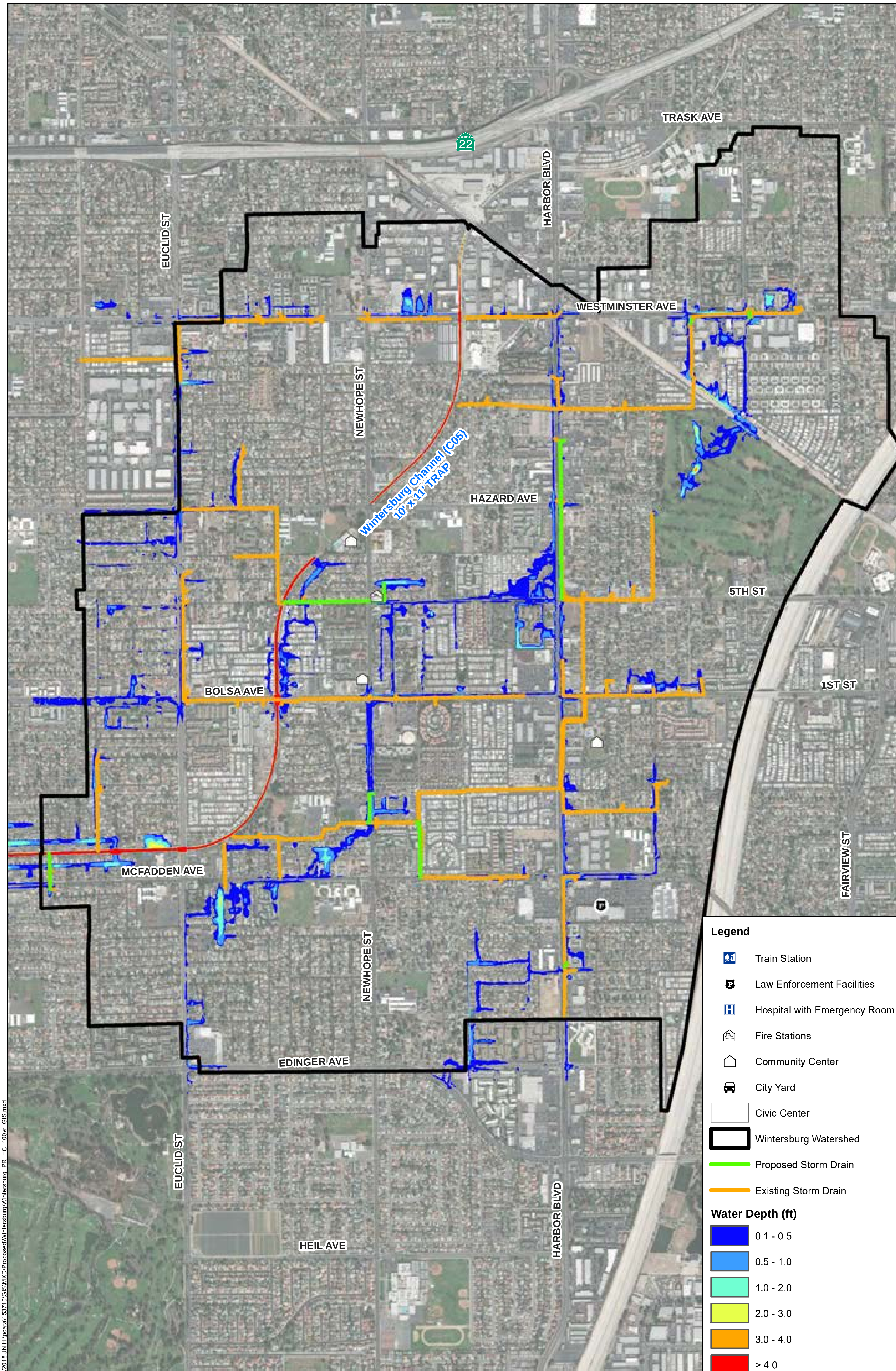
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - Maximum Flooded Depth Map

10- year Proposed Condition

Figure 11-6



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Michael Baker INTERNATIONAL

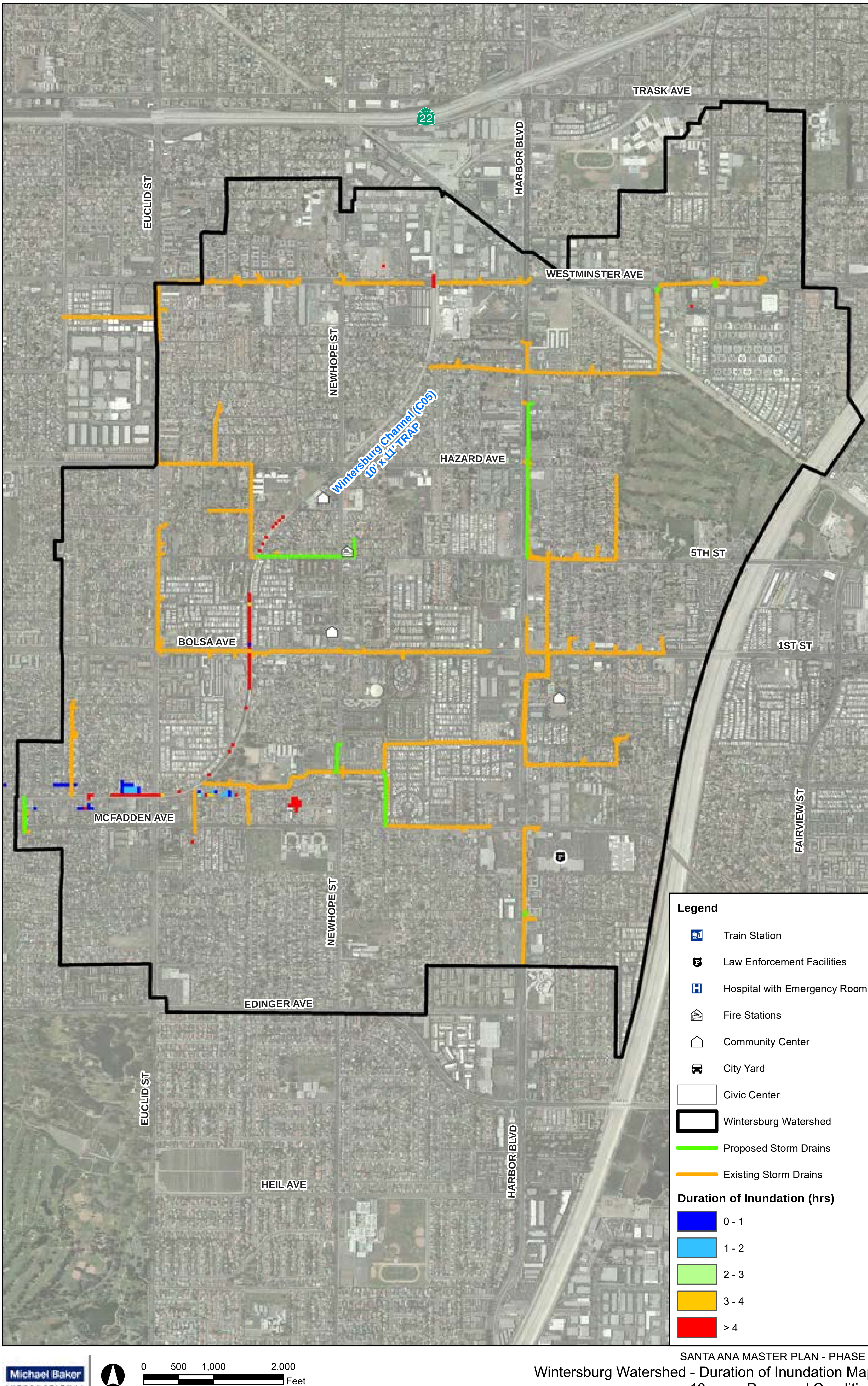
0 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - Maximum Flooded Depth Map

100- year Proposed Condition

Figure 11-7



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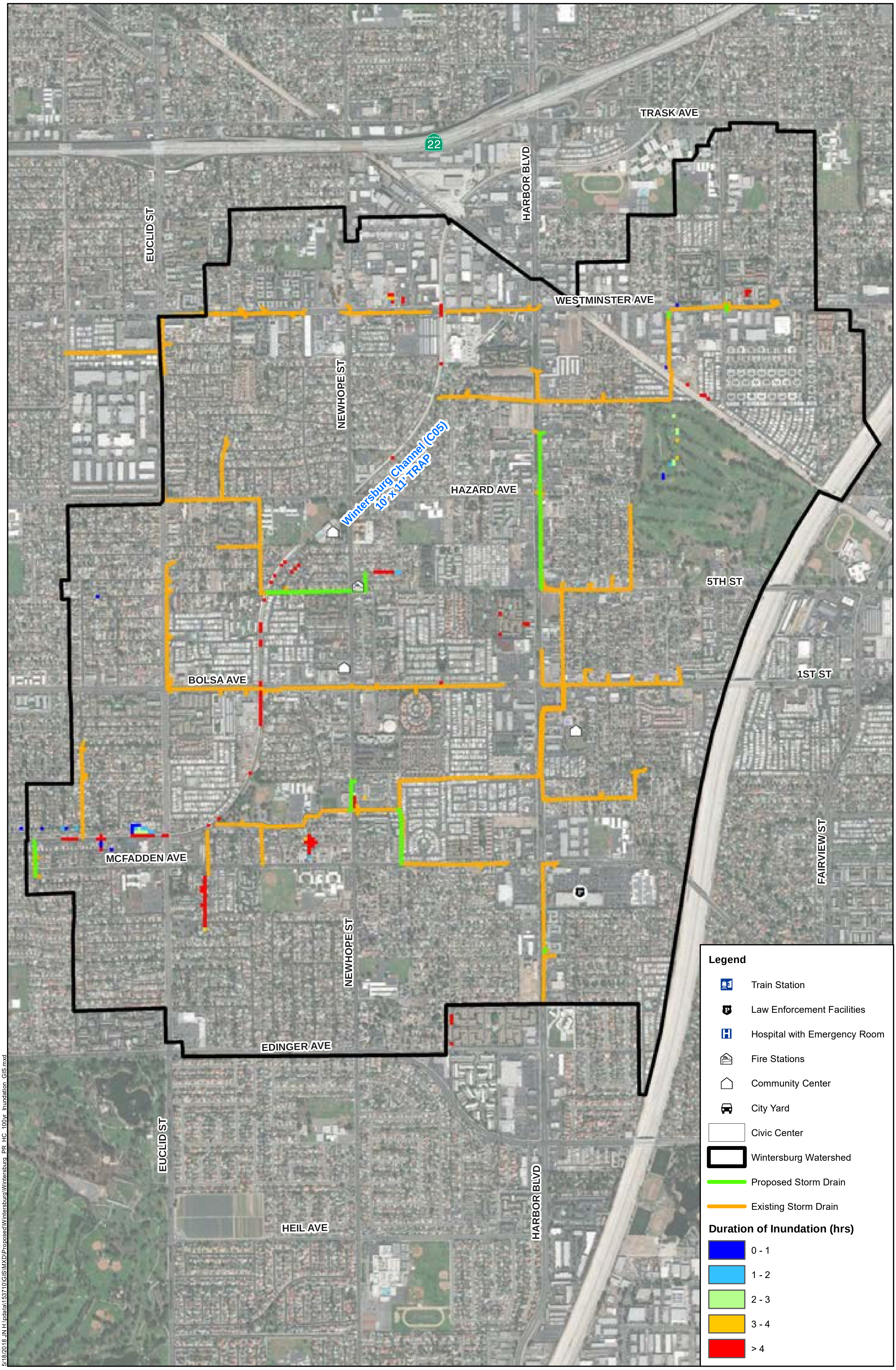
Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - Duration of Inundation Map

10- year Proposed Condition

Figure 11-8



Michael Baker INTERNATIONAL

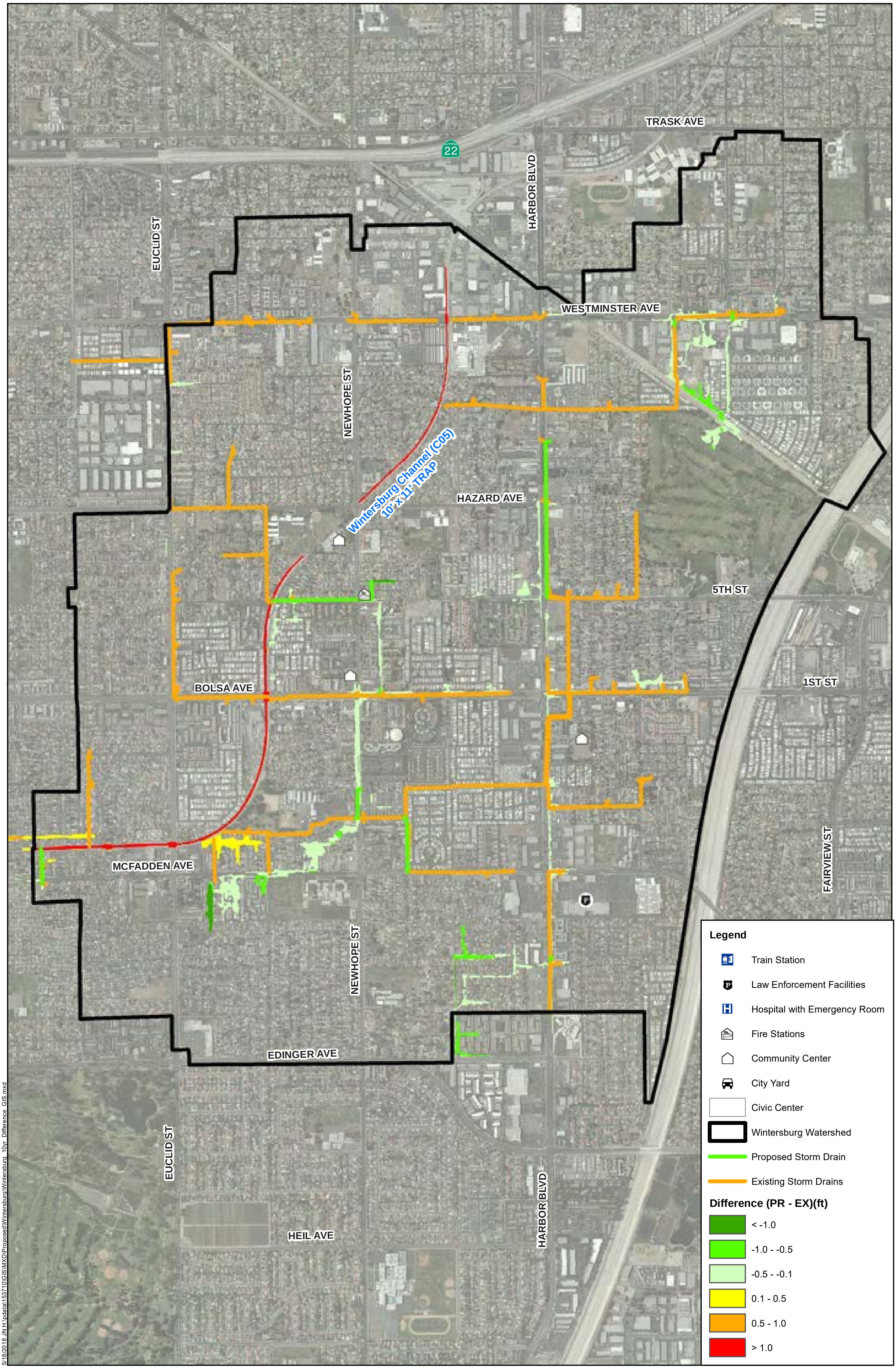
0 500 1,000 Feet

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - Time of Inundation Map

100- year Proposed Condition

Figure 11-9

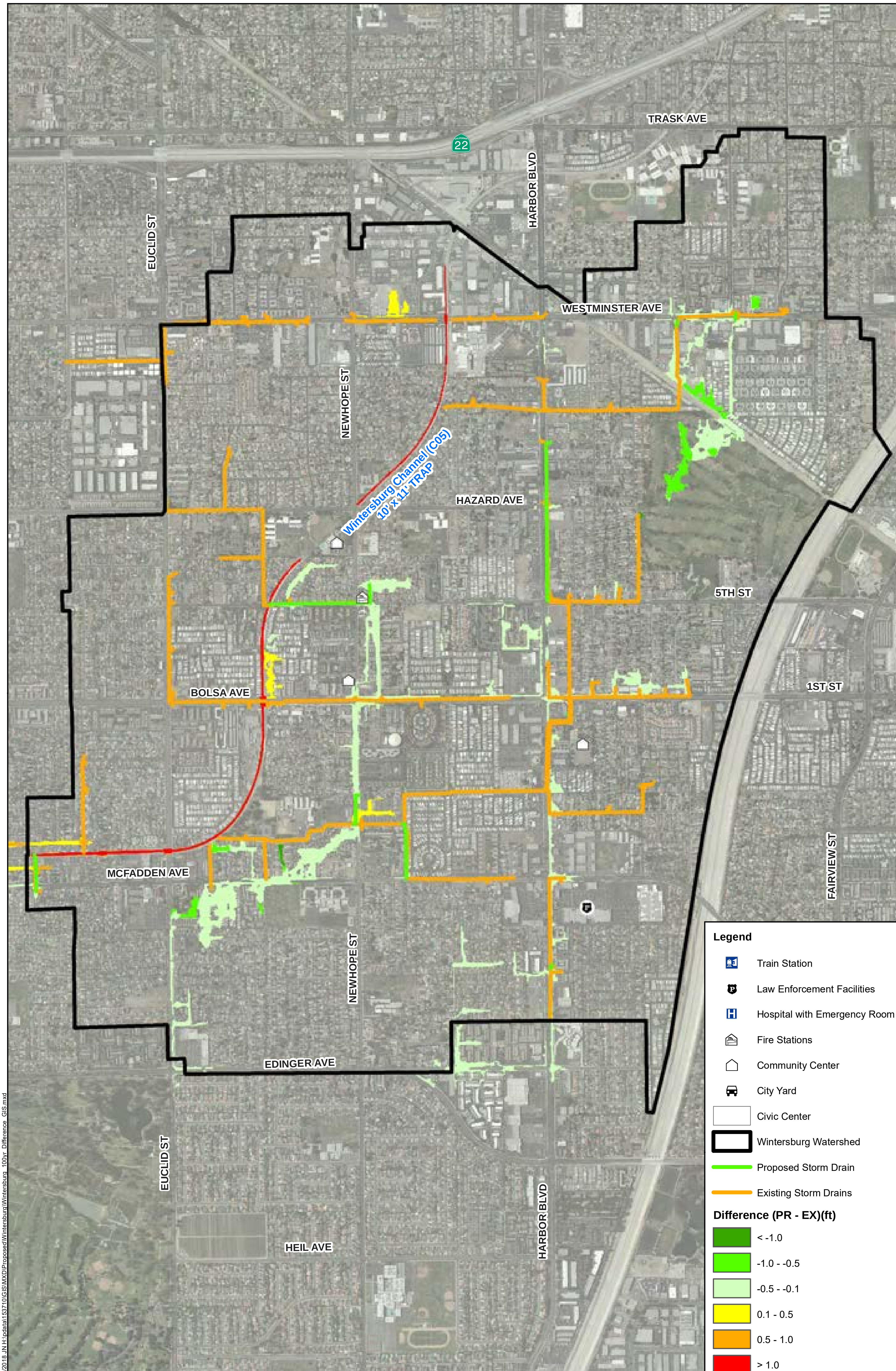


Michael Baker INTERNATIONAL

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - 10 - year Difference Map

Figure 11-10



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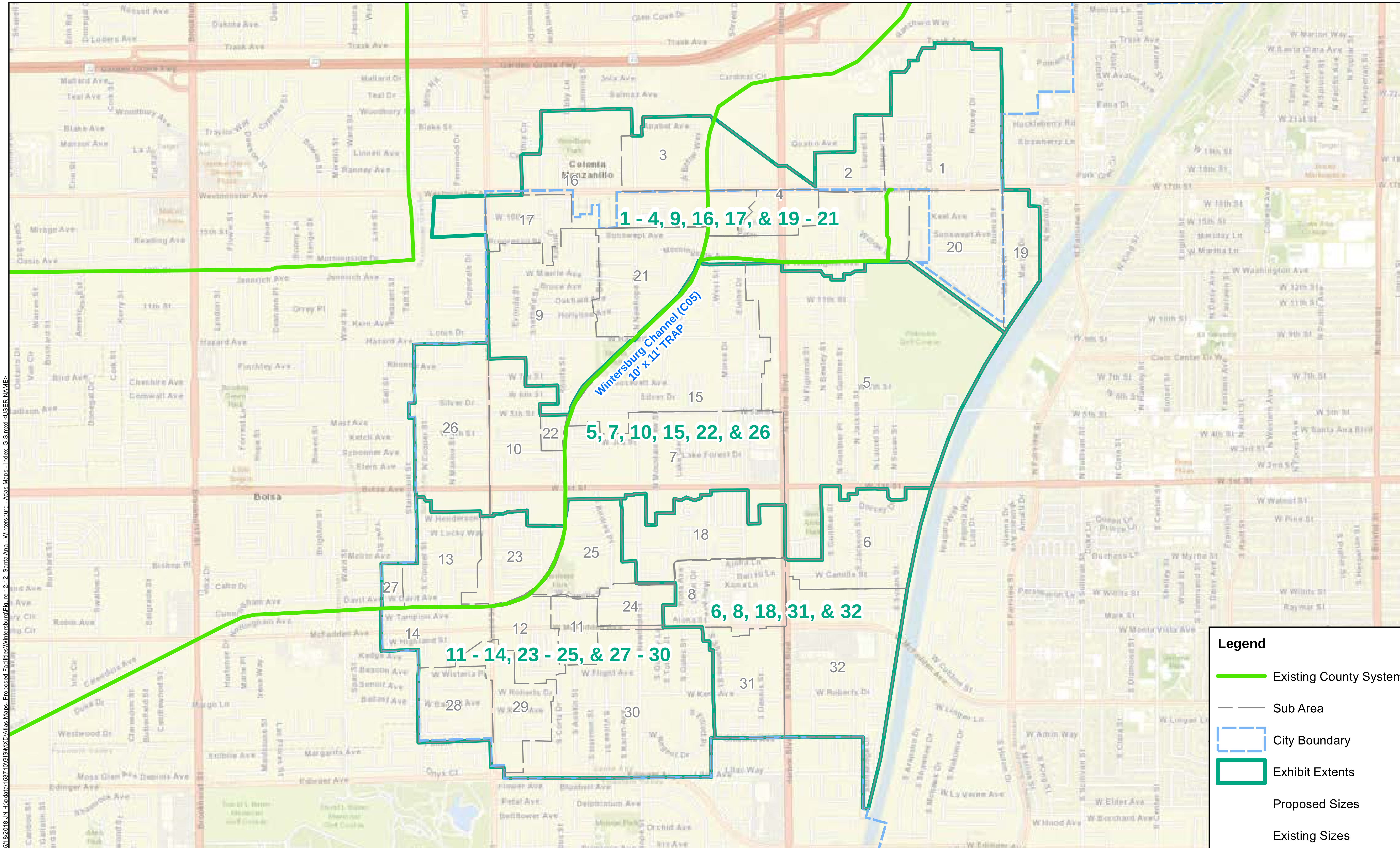
Michael Baker INTERNATIONAL

Source:

SANTA ANA MASTER PLAN - PHASE 2

Wintersburg Watershed - 100 - year Difference Map

Figure 11-11



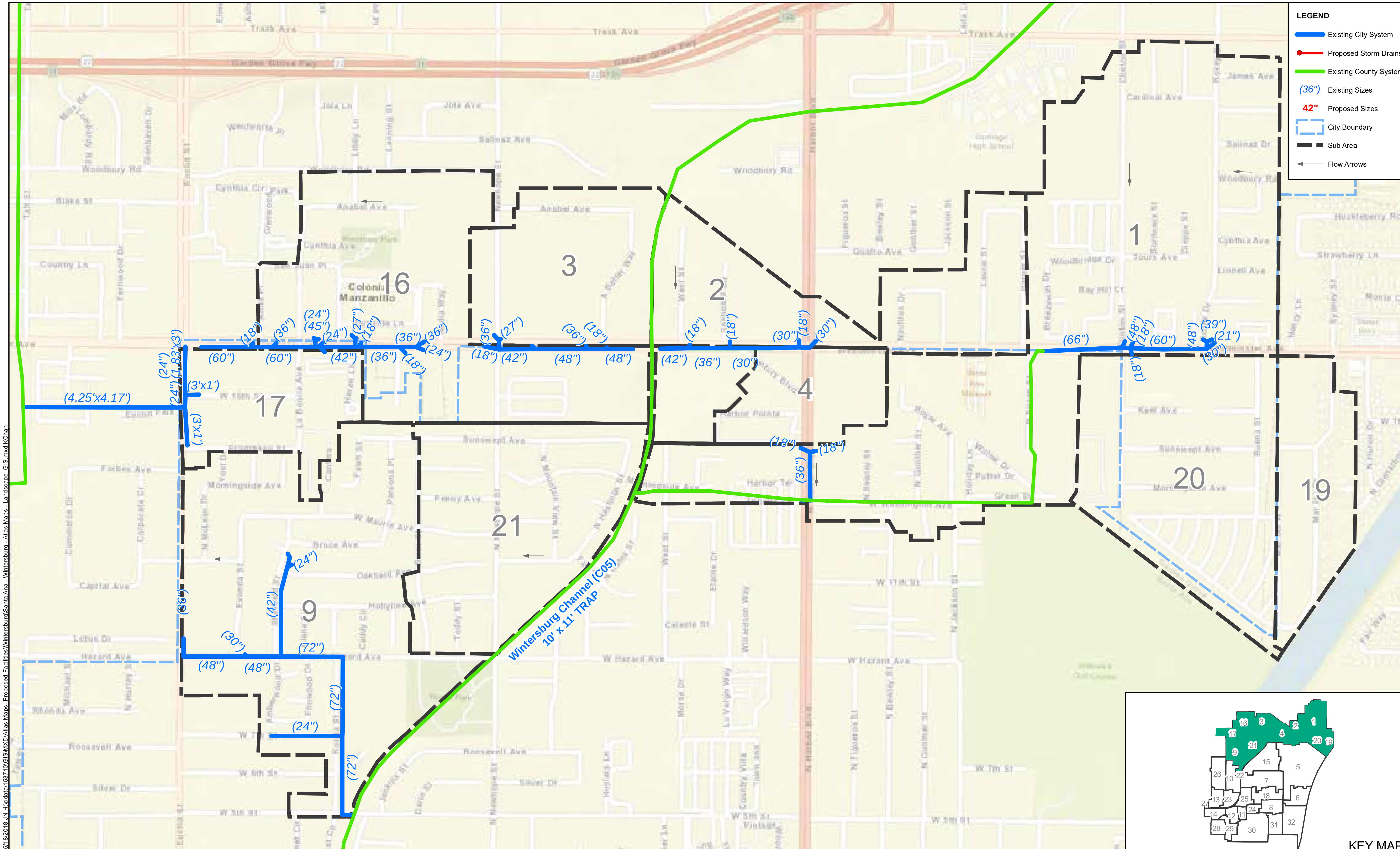
0 500 1,000
Feet

Source:

SANTA ANA MASTER PLAN OF DRAINAGE
WINTERSBURG WATERSHED

Proposed Facilities - Exhibit Extents Index Map

Figure 11-12



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Michael Baker INTERNATIONAL

N

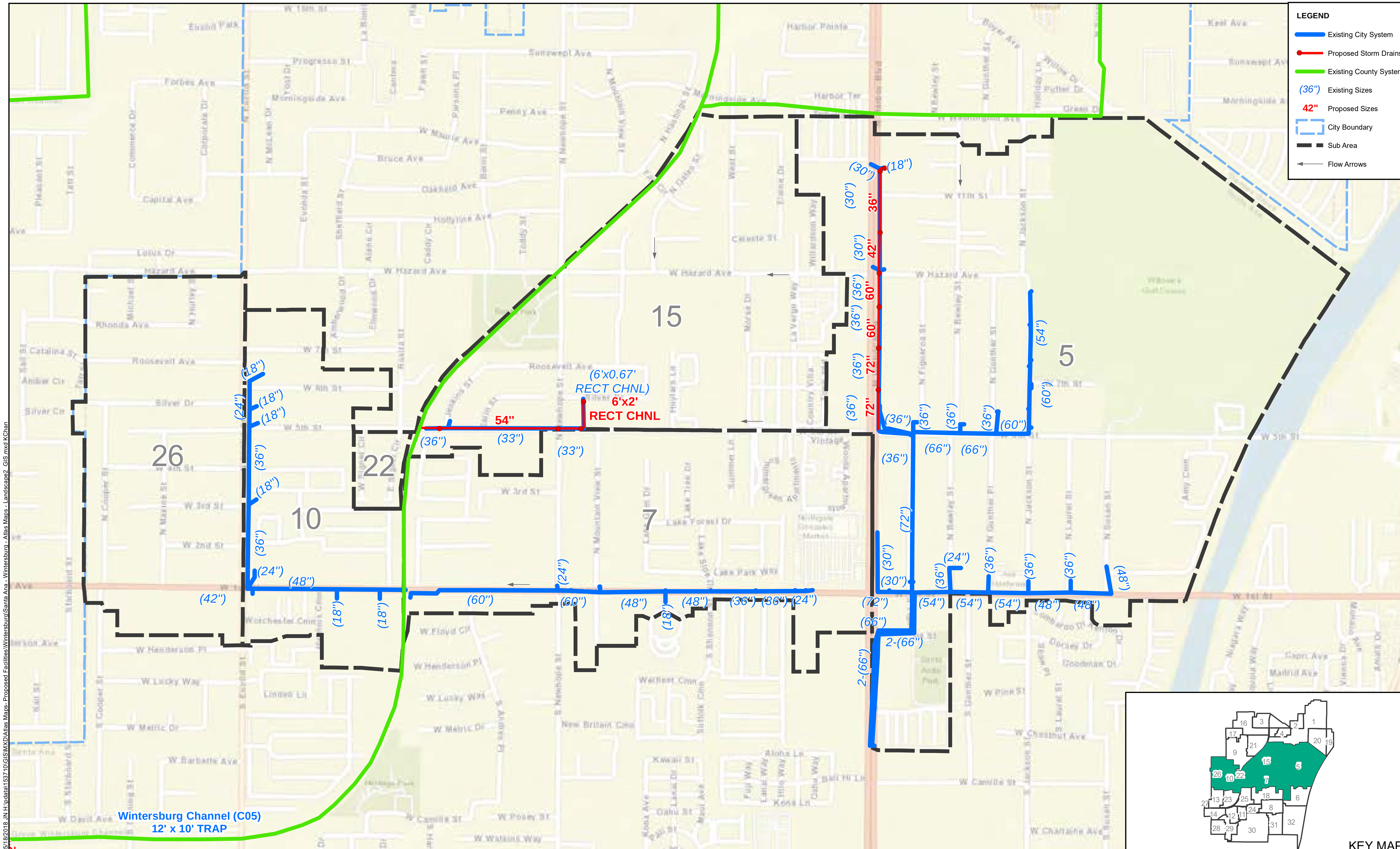
0 500 1,000 Feet

Source: Basemap - Esri

SANTA ANA MASTER PLAN OF DRAINAGE
WINTERSBURG WATERSHED

PROPOSED FACILITIES - SUB AREAS 1 - 4, 9, 16, 17, & 19 - 21

FIGURE 11-13



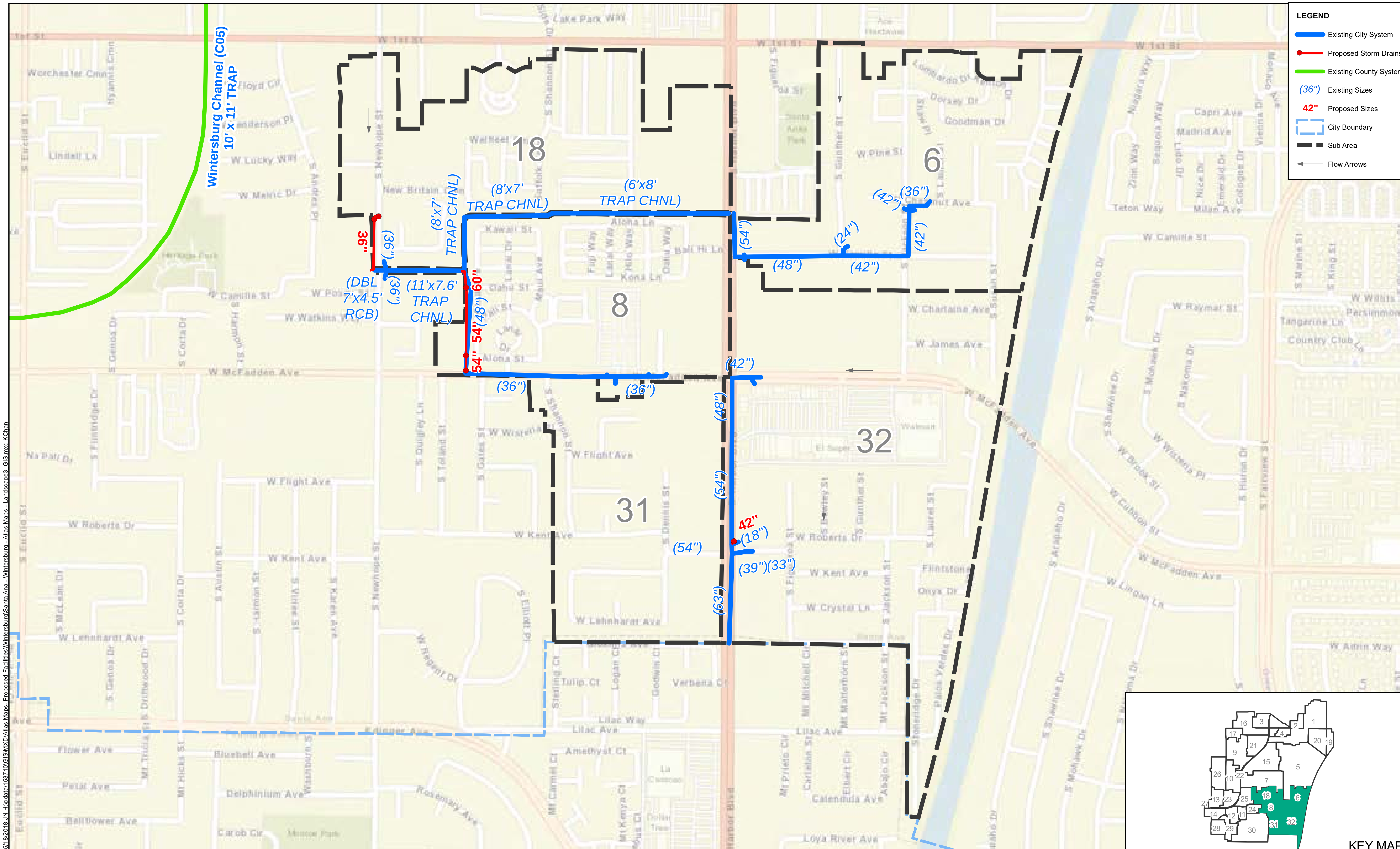
Source: Basemap - Esri

0 500 1,000 Feet

SANTA ANA MASTER PLAN OF DRAINAGE
WINTERSBURG WATERSHED

PROPOSED FACILITIES - SUB AREAS 5, 7, 10, 15, 22, & 26

FIGURE 11-14



Michael Baker INTERNATIONAL

N

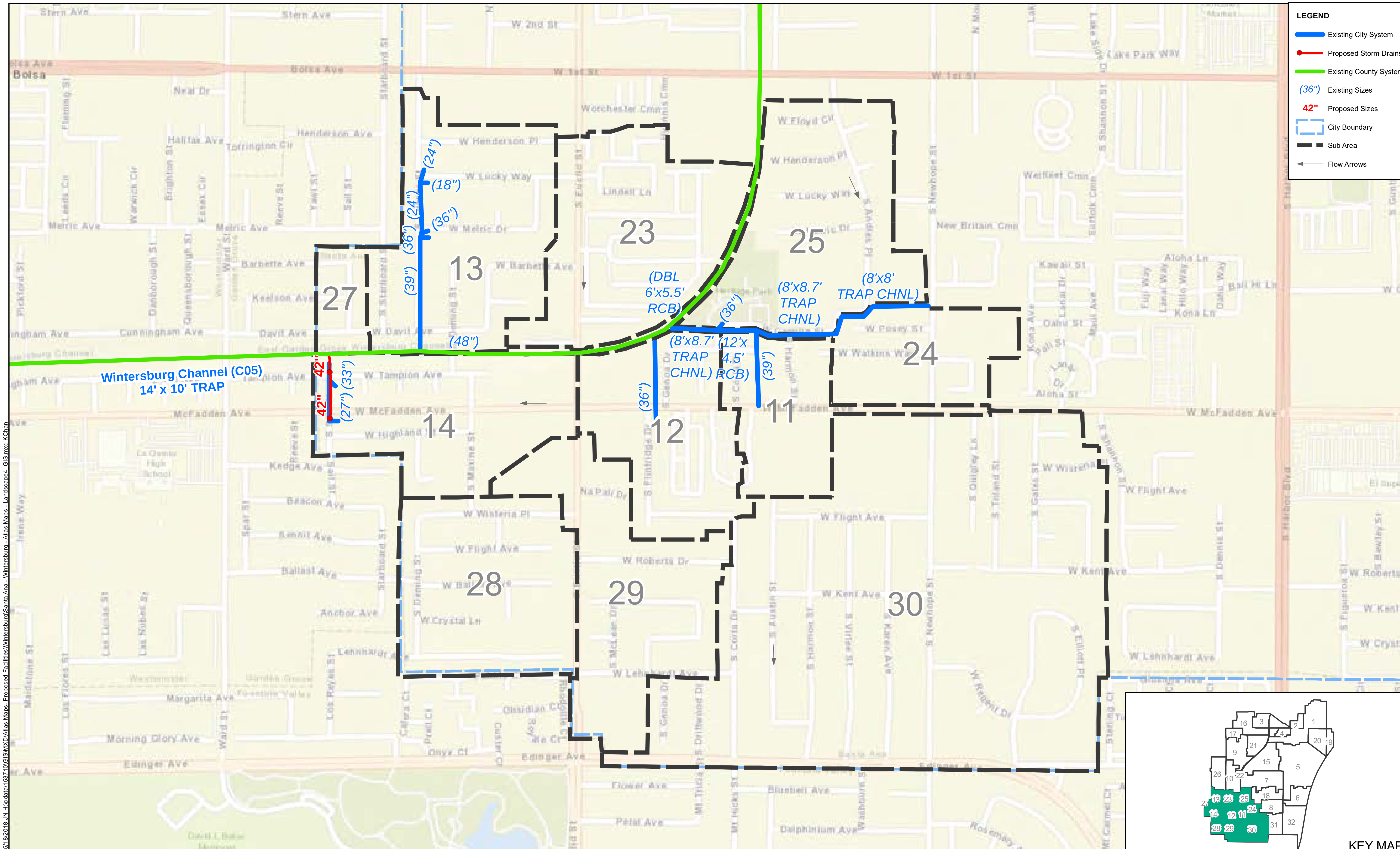
0 500 1,000 Feet

Source: Basemap - Esri

SANTA ANA MASTER PLAN OF DRAINAGE
WINTERSBURG WATERSHED

PROPOSED FACILITIES - SUB AREAS 6, 8, 18, 31, & 32

FIGURE 11-15



0 500 1,000 Feet

Source: Basemap - Esri

SANTA ANA MASTER PLAN OF DRAINAGE
WINTERSBURG WATERSHED

PROPOSED FACILITIES - SUB AREAS 11 - 14, 23 - 25, & 27 - 30

FIGURE 11-16